NEAR-BOTTOM CURRENTS IN MONTEREY SUBMARINE CANYON AND ON THE ADJACENT SHELF

by

William Albert Caster

United States
Naval Postgraduate School

THESIS

NEAR-BOTTOM CURRENTS IN MONTEREY SUBMARINE CANYON AND ON THE ADJACENT SHELF

by

William Albert Caster

October 1969

Near-Bottom Currents in Monterey Submarine Canyon

and on the Adjacent Shelf

by

William Albert Caster
Lieutenant, United States Coast Guard
B.S., United States Coast Guard Academy, 1963

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OCEANOGRAPHY

from the

NAVAL POSTGRADUATE SCHOOL
October 1969

ABSTRACT

Near-bottom currents in Monterey Submarine Canyon and the adjacent shelf were collected using Savonius current meters. Simultaneous measurements were made with one current meter on the shelf at a depth of 91 meters and one meter located in the Canyon at 366 meters. Another record was taken in the Canyon at the 366-meter location. Current speed, current direction and water temperature were recorded continuously for approximately seven days in each record. First-order statistics were calculated and plotted for these time-series data. Scatter diagrams, progressive vector diagrams and power spectra were also computed and analyzed for the records collected during this study and for records of sufficient length from previous investigations.

Net current set was in a cross-canyon direction for many of the records; however, the currents in the Canyon oscillated as reported in previous investigations. The oscillations were not as evident on the shelf record. Mean and maximum current speeds recorded in the Canyon were 10 and 51 cm/sec, respectively. On the shelf these values were 7 and 25 cm/sec. Observed values of net current set and volume transport are related to Monterey Bay seasonal water conditions.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The author expresses his sincere appreciation to Professor Warren W. Denner, Department of Oceanography, Naval Postgraduate School, for his advice during the course of this investigation. Thanks are due the oceanographic support personnel who assisted in this study, especially Mr. Jack Mellor; the staffs of the Computer Facility and the Machine Facility, Naval Postgraduate School, and the crew of the School's research vessel. The assistance of Mr. J. R. Wilson of the Institute of Oceanography of the University of British Columbia in using the power spectrum program is appreciated. A special thanks is due my wife for her assistance in reducing the data from the strip-chart records.

I. INTRODUCTION

A. SUBMARINE CANYONS

Submarine canyons were first studied toward the end of the nineteenth century; however, detailed studies were not made until the 1930s [Kuenen, 1960]. Veatch and Smith [1939] compiled a set of detailed contour charts of the submarine canyons of the east coast of the United States and the Congo Submarine Canyon. Work on the canyons of the west coast of the United States was begun by Francis Shepard during this same period. The report by Shepard and Emery [1941] on California canyons is considered to be one of the most important papers in the field [Martin, 1964].

The formation of canyons has been a much debated subject. Kuenen [1960] suggested several possible mechanisms for canyon formation including: (1) diastrophic origin, (2) warping of the continental borderland, (3) artesian spring sapping, (4) mudflows and landslides, (5) tsunamis, (6) hydraulic and tidal currents and (7) effects due to the Ice Age related to excessive lowering of sea level and turbidity currents.

Shepard [1963] suggests that no one process alone can explain the formation of submarine canyons. He feels that some were caused by diastrophism, turbidity currents and stream erosion from the lowering of sea level; however, he concludes that more study is required.

Submarine canyons are a unique feature of the continental margins and play an important part in local ocean processes such as sediment transport, circulation, oscillations, biological activity and weather conditions. Current measurements thus have an important part in the complete understanding of the processes occurring in a canyon.

B. PREVIOUS INVESTIGATORS OF CURRENTS IN SUBMARINE CANYONS

Early investigators of near-bottom currents in submarine canyons used Ekman type current meters. Stetson [1937] measured currents in three canyons on Georges Bank and found the maximum currents to be 11.8 cm/sec during flood tide and 10.37 cm/sec during the ebb tide. These canyon currents were higher than the shelf currents in the same area. He felt that the currents could preserve the canyons but not form them. Shepard, Revelle and Dietz [1939] found maximum current speeds of 26.9 cm/sec in Monterey Submarine Canyon and speeds in excess of 20 cm/sec in canyons off Southern California. These measurements were taken approximately one meter off the bottom at depths of 42 to 840 meters. Although Stetson felt the currents were strongly related to the tide, Shepard, _et al_, [1964] using a diving saucer estimated down-canyon currents of 10 cm/sec and suggested that the currents might be due to internal waves, surf beat and seaward return of water carried inshore by swell.

Gatje and Pizinger [1965] made 75 observations using an Ekman current meter on nine different days in February and March 1965 in the Monterey Submarine Canyon. The current meter was placed 4.9 meters above the bottom in 132 meters of water. The most frequently observed speed was 22.7 cm/sec. There were eight readings higher than 25.7 cm/sec with the highest being 41.8 cm/sec and the second highest 30.9 cm/sec. The median speed was 10.3 cm/sec. Current direction showed a bimodal distribution with the modes separated by approximately 180°. By comparing current direction with the Canyon axis, they found that the flow was predominately up- and down-canyon. Current direction reversal coincided with high and low tide but the flow was out of phase with the tide, often by 180°; that is, down-canyon flow was associated with rising tide and up-canyon flow with falling tide.

Dooley [1968] continued, in Monterey Submarine Canyon, investigation of near-bottom currents using Savonius current meters recording speed, direction and water temperature. Observations were made in March, April and November 1967 and January, February, April and May 1968. Measurements were taken at depths of 118 to 165 meters with the current meters 16 meters above the bottom.

Current speeds averaged from 5.7 to 15.8 cm/sec and ranged from zero to 51.5 cm/sec. Direction of flow seemed to be predominately along the axis of the Canyon; however, other current directions were observed. Direction showed a bimodal tendency for all records except November's which was unimodal.

Spectral estimates of speed and temperature showed a prominent peak at 12 hours. Speed also had peaks from four to six hours and two to three hours. The direction reversed frequently at 12-hour intervals. The consistent strong energy peak at 12 hours suggested an association with the semidiurnal tidal component; however, no clear relationship between tidal movement and Canyon current was seen by Dooley from correlation of the Canyon currents and the tide marigram of Monterey Harbor.

Interestingly, the currents exhibited rapid bursts of speed, sometimes increasing 41.2 cm/sec in 1.5 minutes. The maximum bursts would take only three minutes to develop and slowly decrease after 20 to 30 minutes. On several occasions sustained speeds of 41.2

cm/sec were seen to last one hour. Dooley found that an increase in current speed, in most cases, accompanied a decrease in temperature.

Njus [1968] continued the study of near-bottom currents in the Monterey Submarine Canyon. He made three moorings during September and October 1968, each 12.2 meters above the bottom and at depths of 150, 165 and 201 meters. He found periodic reversal of current direction which was generally along the Canyon axis. Direction reversals occurred primarily at high and low tide. The up-canyon flow of cold water was associated with a falling tide. Speed increased from zero to approximately 51.5 cm/sec and then decreased. On the rising tide, the direction reversed and warm water flowed down-canyon increasing from zero to a maximum and then decreasing to a minimum to start the cycle again. Average current speeds for his good records obtained at 165 and 201 meters were 25.7 and 34.5 cm/sec. Power spectrum of temperature and speed showed peaks at 12.5, six and four hours, and the direction of the flow exhibited several reversals at a tidal frequency. There was good correlation between current speed and direction and water temperature at tidal periods.

Squire [1969] used aircraft-launched seabed drifters to study the bottom drift in Monterey Bay. He made two launches, one on 25 May 1962 consisting of 115 seabed drifters and one on 15 February 1963 using 172 drifters. Nine and fifteen drifters were recovered representing a recovery rate of 7.5% and 15% respectively. Three recoveries from the first launch were from the Monterey Submarine Canyon. One was at a depth of 915 meters and two were at a depth of 549 meters. Cumulative drift rate was reported as 0.07 km/day (0.08 cm/sec) to the northeast for one of the 549-meter drifters and for the 915-meter drifter. The other 549-meter drifter was recovered

1,456 days after launch; therefore, the cumulative drift rate was not calculated. Drifters in the Canyon from the second launch showed drifts of less than 0.06 km/day (0.07 cm/sec) to the east. In general, the lowest drift rates for the Bay were reported from the drifters dropped into the Canyon.

Shepard and Marshall [1969], using the Isaacs-Schick continuous recording current meter system, measured currents in submarine canyons off La Jolla, California. Their measurements, 3.6 meters above the bottom, of three to six days, included simultaneous stations of up to six current meters and in La Jolla Canyon a vertical array of three current meters 3.6, 19 and 34 meters above the bottom. They reported that there is no relationship between the tide and current flow at this location. Although correlation between two stations was high, flows in opposite directions did occur. They felt that this suggested cellular flow.

C. PURPOSE OF THIS INVESTIGATION

The purpose of this research was to: (1) continue near-bottom current measurements in the Monterey Submarine Canyon, extending the work of previous investigators into deeper regions of the Canyon and onto the surrounding shelf, (2) calculate the power spectra and volume transport for all continuous records of sufficient length using new programs specifically designed for the purpose and (3) analyze all continuous records to determine significant peaks in the energy spectrum and trends in the volume transport, define more clearly the relationship between tidal forces and the currents in the Canyon, investigate the relationship between the currents on the shelf and in the Canyon, and study the relationship of observed current set and volume transport with the Monterey Bay seasonal periods.

II. REGION OF OBSERVATION

A. MONTEREY BAY

Monterey Bay is located 121 km south of San Francisco (Figure 1) and is in open communications with the Pacific Ocean, thus subject to oceanic variations. Skogsberg [1936] has divided the Bay's water conditions into three periods: (1) the Davidson Period - from the middle of November to the middle of February, when the Davidson Current brings relatively warm water northward near shore, (2) the upwelling period - between the middle of February and the end of July when cold waters upwell in the Bay and (3) the oceanic period - from the end of July until the middle of November, when the California Current transports cooler water southward.

B. MONTEREY SUBMARINE CANYON

The bottom of the Bay is cut by a large V-shaped, meandering canyon called the Monterey Submarine Canyon (Figure 2). This Canyon is one of the largest in the world and has two tributaries, the Carmel Canyon to the south and the smaller Soquel Canyon to the north. The Canyon extends seaward some 53 km into the Monterey Trough which continues 51.5 km further with diminishing relief. Beyond the Trough, deep channels have been traced for 250 km giving a total of 354.5 km for the extent of the Monterey Canyon, Trough and Deep-sea Channels. Side slopes for the Monterey Canyon range from 5 to 34 degrees; slopes for the Soquel and Carmel Canyons range from 8 to 40 degrees and 1 to 25 degrees respectively. Monterey Canyon's axial gradient flattens from 8.5 degrees at its head to 0.5 degrees at the seaward limit [Martin and Emery, 1967].

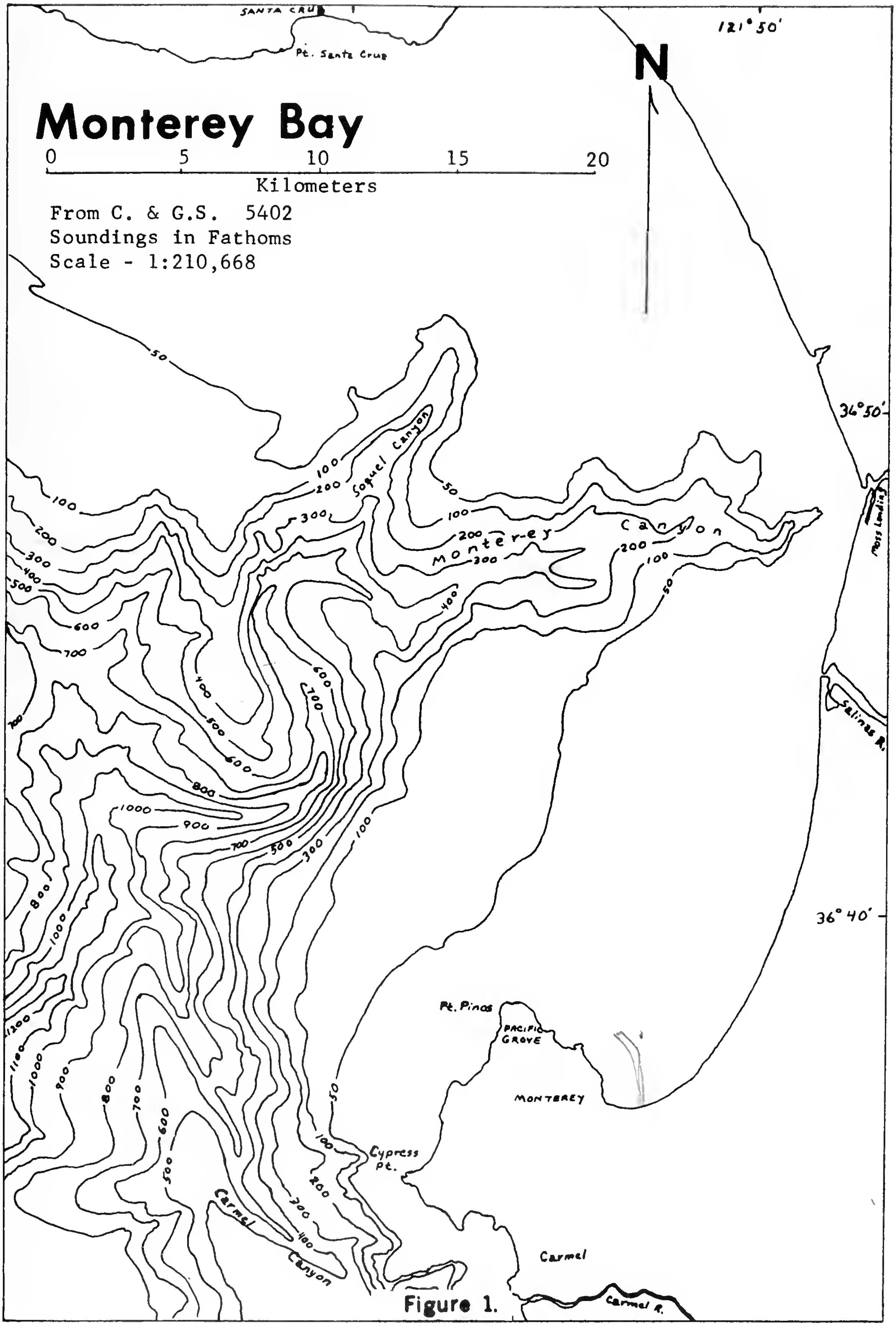

Monterey Bay
0 5 10 15 20
Kilometers
From C. & G.S. 5402
Soundings in Fathoms
Scale - 1:210,668
N
121°50'
36°50'
36°40'
SANTA CRUZ
Pt. Santa Cruz
Soquel Canyon
Monterey Canyon
Moss Landing
Salinas R.
Pt. Pinos
PACIFIC GROVE
MONTEREY
Cypress Pt.
Carmel Canyon
Carmel
Carmel R.

Figure 1.

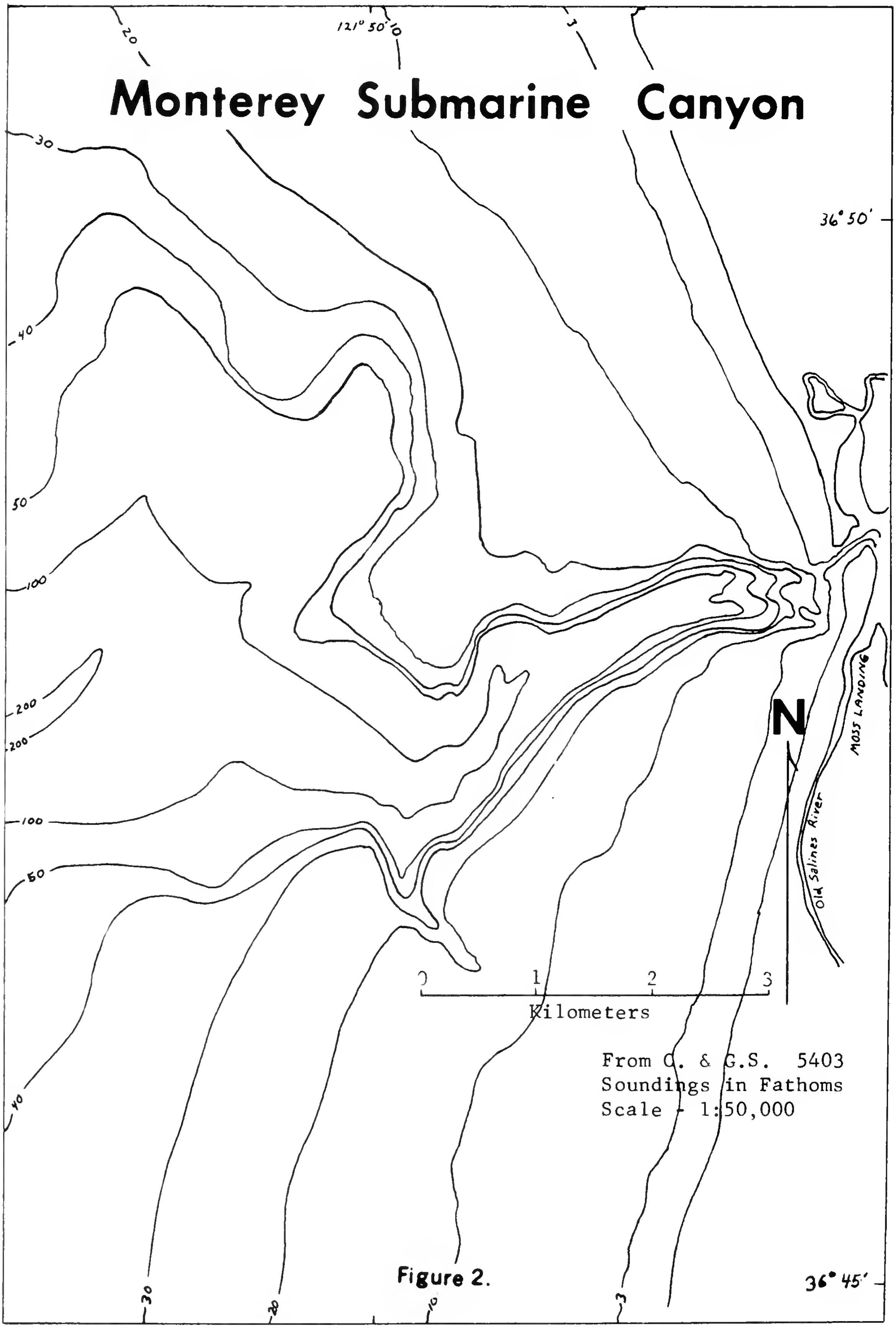

Monterey Submarine Canyon
121° 50′
20
10
3
30
36° 50′
40
50
100
200
200
100
50
40
N
MOSS LANDING
Old Salines River
0 1 2 3
Kilometers
From C. & G.S. 5403
Soundings in Fathoms
Scale - 1:50,000
30
20
10
3
36° 45′

Figure 2.

III. MEASURING EQUIPMENT AND PROCEDURES

A. CURRENT MEASURING SYSTEM

All the current data analyzed in this investigation were collected with Hydro Products Model 501B Savonius current meters. This meter is a self-contained instrument package measuring current speed and direction as well as water temperature. The current sensor is a Savonius rotor, the direction sensor is a coupled potentiometer reading relative to a magnetic compass and the temperature sensor is a thermistor. The readout package is a solid-state circuit connected to a two-inch Rustrak paper chart recorder. A self-contained, rechargeable 6-volt nickel cadium battery pack is used for the system's power.

On the scale used in this investigation, the speed range is zero to one knot (51.5 cm/sec) with a threshold of 0.05 knot and an accuracy $\pm$ 3% of the reading. The direction has an accuracy of $\pm$ 5 degrees. Temperature between zero and $40^{o}C$ can be recorded to an accuracy of $\pm$ 3% of the reading. A seven-day continuous record of current speed is possible, but the temperature and direction use the same channel and the system switches between these sensors. The three readouts recorded (Figure 3) on the two-inch wide strip chart are distinguished by their appearance as a series of dots whose lengths are proportional to the recorded time for each one of the inputs.

The switching sequence for the seven-day recording interval is continuous speed, direction for five minutes, temperature for $1\frac{1}{2}$ minutes and neither direction nor temperature for one minute. The sequence then begins again Franz, [1967]. The sensors and the recorder electronics

STRIP CHART

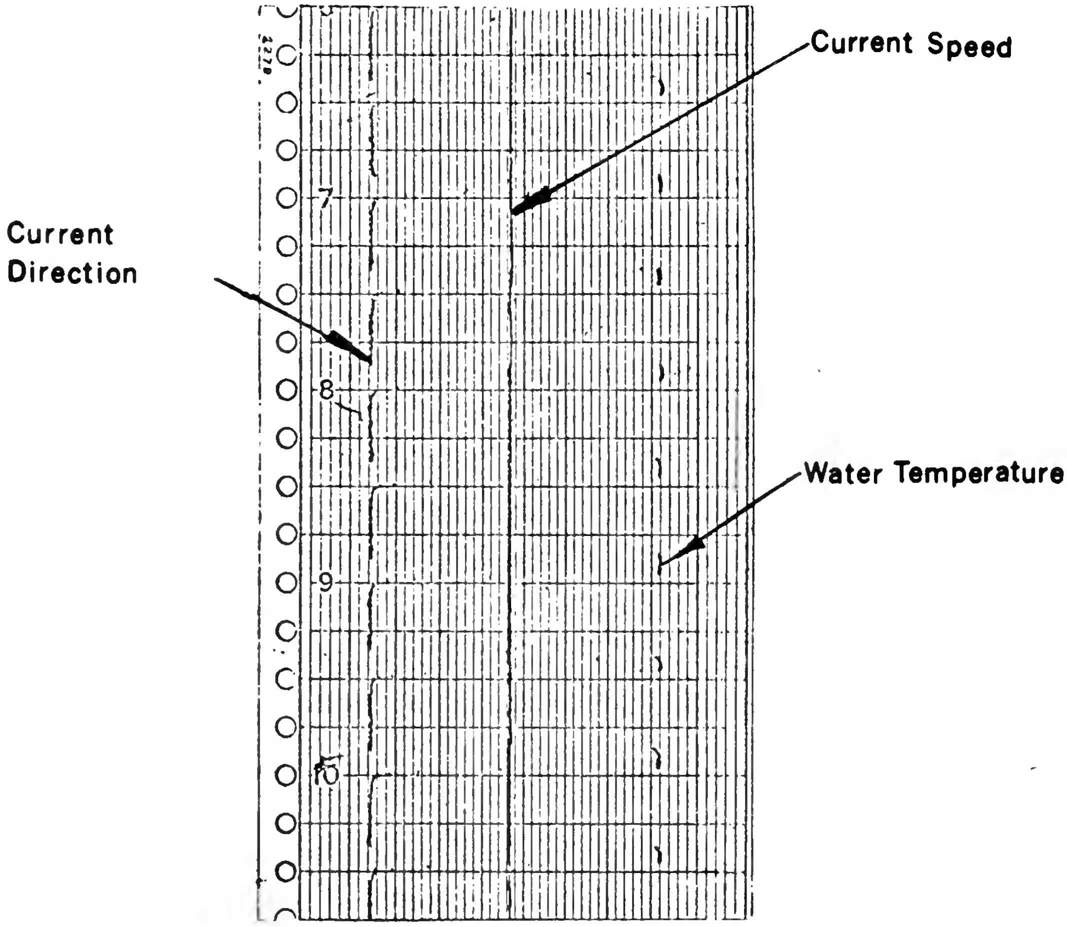


Figure 3.

are mounted in a bird-cage frame. A 102 by 61 cm aluminum vane was attached to the current meter frame to give better directional stability.

B. RELEASE MECHANISM

The timed release mechanism used was the Braincon Model 422 release. The release mechanism allowed the measuring system to return to the surface for recovery. After the timing mechanism has counted down from its preset time, an explosive squib fires which allows the release to disengage the line connecting the release and the mooring weights.

C. TAUT-LINE MOORING SYSTEM AND MOORING PROCEDURE

Three moorings were successfully established during the course of this investigation. The measurements were made as close as practicable to the bottom to allow convenient setting of the mooring and to be above any rock outcrops. The taut-line mooring system (Figure 4) used was very similar to that developed by Dooley [1968] and later used by Njus [1968]. Appendix A discusses problems encountered with the taut-line moor.

Navigation was by visual or radar fixes from the Naval Postgraduate School (NPS) sixty-three foot research boat. Depths were determined using the vessel's fathometer. As the mooring site was approached, the recoverable section was paid out and allowed to stream behind the boat. When the proper location was reached, the current meter and release were lowered over the side and then the mooring weights were dropped.

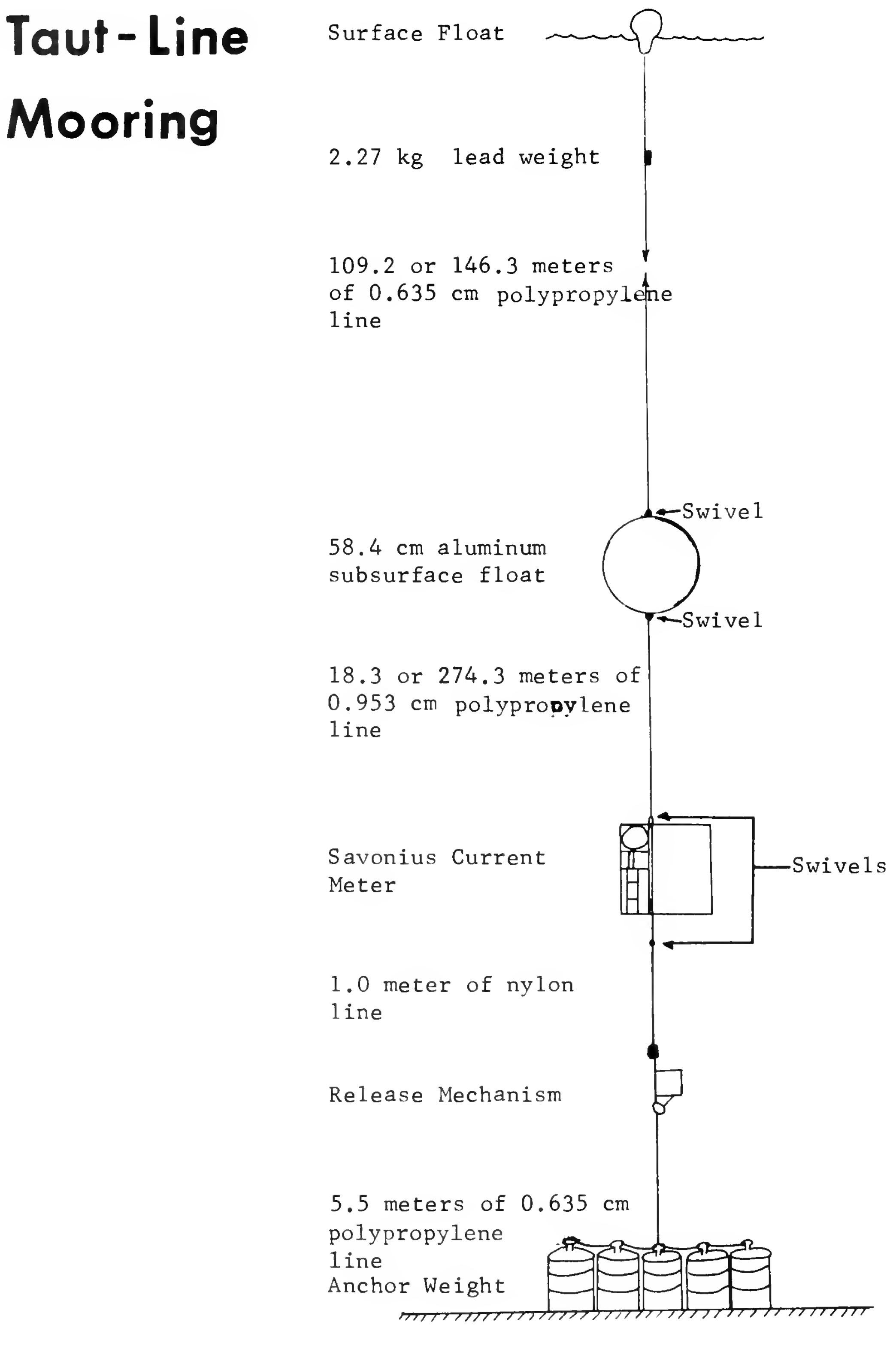

Taut-Line Mooring
Surface Float
2.27 kg lead weight
109.2 or 146.3 meters
of 0.635 cm polypropylene
line
Swivel
58.4 cm aluminum
subsurface float
Swivel
18.3 or 274.3 meters of
0.953 cm polypropylene
line
Savonius Current
Meter
Swivels
1.0 meter of nylon
line
Release Mechanism
5.5 meters of 0.635 cm
polypropylene
line
Anchor Weight

Figure 4.

D. TIDE RECORDING EQUIPMENT

Tidal records were obtained from a standard recording tide gauge located on Wharf Number 2 in Monterey Harbor. The heights of the tide are the same in Monterey as at Moss Landing and the time difference of three minutes was ignored [Dooley, 1968].

IV. CONTINUOUS TIME-SERIES CURRENT OBSERVATIONS

Six moorings were attempted during this investigation and three moorings were successfully completed. Two were set simultaneously on 11 April 1969, one in the Canyon at a depth of 366 meters and another on the north shelf of the Canyon at a depth of 91 meters. A third moor was made on 25 April 1969 at the previous 366-meter site.

Dooley [1968] made nine moors. Five yielded data in excess of 50 hours and were reanalyzed during the course of this investigation. Njus [1968] made three successful moors. The first did not record current speed; hence, only the latter two were reanalyzed in this study. Figure 5 indicates the sites occupied in this and previous investigations and Table I summarizes the successful observations of this and earlier work.

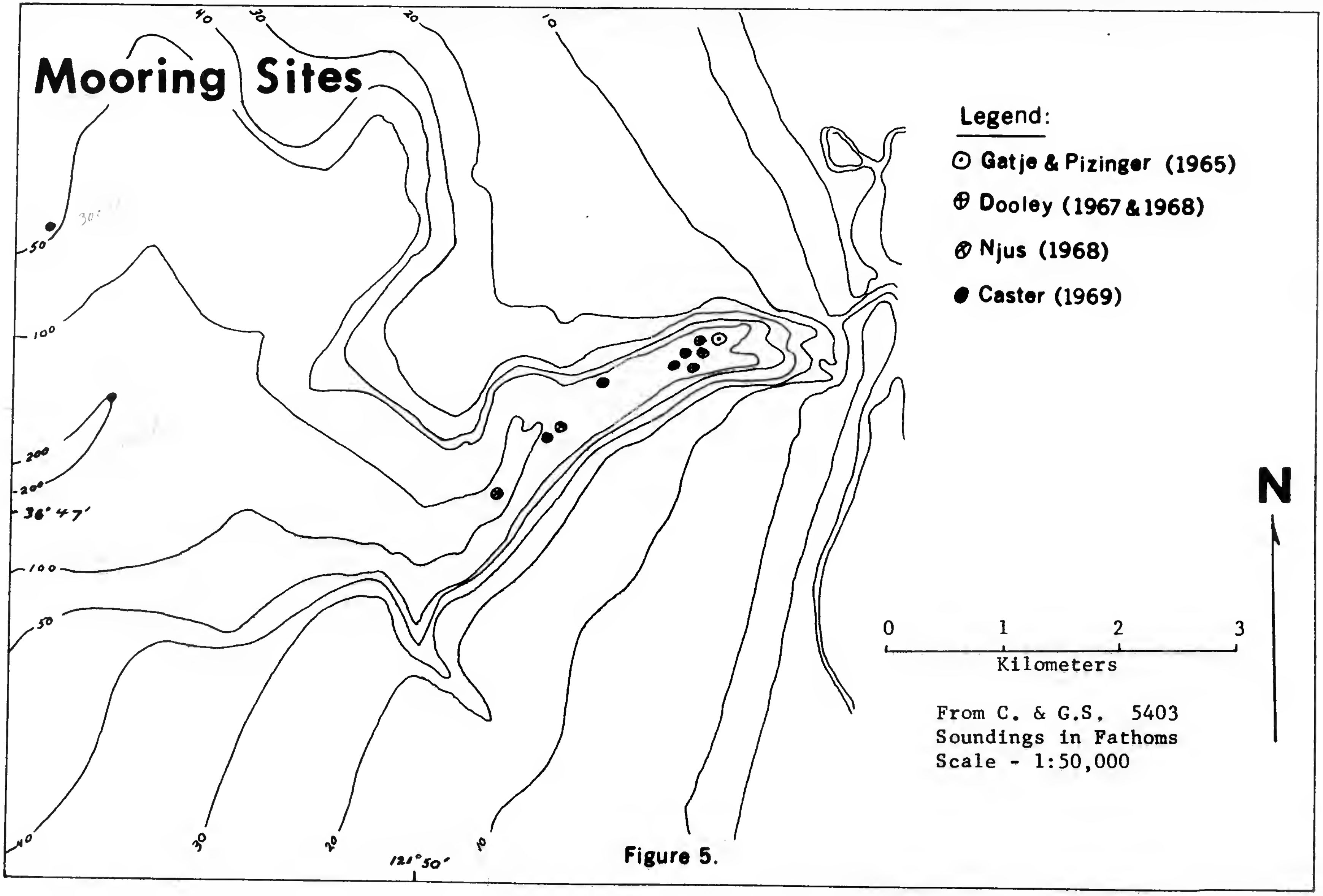

Mooring Sites
Legend:
Gatje & Pizinger (1965)
Dooley (1967 & 1968)
Njus (1968)
Caster (1969)
N
0
1
2
3
Kilometers
From C. & G.S. 5403
Soundings in Fathoms
Scale - 1:50,000
36°47'
121°50'

Figure 5.

TABLE I

OBSERVATION PROGRAM

Dooley 1968

START/FINISH TIME (Local)	RECORD LENGTH (Hours)	POSITION	DEPTH (Meters)	REMARKS/ MALFUNCTIONS
1000 22 Mar 67 to 1340 24 Mar 67	50	36°48.09'N 121°48.53'W	119	Testing Taut-Moor
1048 10 Apr 67 to 1454 11 Apr 67	28	36°48.10'N 121°48.60'W	121	Testing Taut-Moor with surface recovery buoy.
1110 24 Nov 67 to 2210 26 Nov 67	56	36°48.15'N 121°48.40'W	128	Ceased recording at 262210, normal recovery at 272310 Nov 67.
1426 15 Jan 68 to 2326 21 Jan 68	153	36°48.10'N 121°48.60'W	133	Recovered buoyancy float by dragging 201500 Jan 68. Recovered meter by dragging 081400 Feb 68. Squib failed to fire after clock time expired.
0945 29 Feb 68 to 1410 2 Mar 68	52	36°47.92'N 121°51.05'W	165	Recovered in surf off Moss Landing 20 Mar 68. Time release failed to disengage after squib fired. Speed rotor malfunction after 52 hrs.
1610 18 Apr 68 to 1439 25 Apr 68	5	36°48.18'N 121°48.18'W	110	Meter malfunction, launched with difficulty in heavy seas.
1307 30 Apr 68 to 1436 7 May 68	0	36°48.18'N 121°48.15'W	95	Meter malfunction, electronics failure.
1515 7 May 68 to 1428 14 May 68	0	36°48.19'N 121°48.20'W	108	Meter malfunction, electronic failure.
1520 14 May 68 to 1526 21 May 68	162	36°48.08'N 121°48.52'W	104	Normal recovery at 211535 May 68.

TABLE I (Continued)

Njus 1968

START/FINISH TIME (Local)	RECORD LENGTH (Hours)	POSITION	DEPTH (Meters)	REMARKS
1030 10 Sep 68 1000 18 Sep 68	89.25	36° 47.90'N 121° 48.90'W	165	1. No speed data obtained. 2. Rustrak recorder malfunctioned.
1230 26 Sep 68 1250 3 Oct 68	168.3	36° 48.05'N 121° 48.70'W	160	
1050 17 Oct 68 0950 24 Oct 68	168	36° 47.50'N 121° 49.35'W	202	

Caster 1969

START/FINISH TIME (Local)	RECORD LENGTH (Hours)	POSITION	DEPTH (Meters)	REMARKS
1215 11 Apr 69 to 1149 18 Apr 69	167.56	36° 47.98'N 121° 51.58'W	366	
1148 11 Apr 69 to 1503 18 Apr 69	171.25	36° 48.76'N 121° 51.98'W	91	
1118 25 Apr 69 to 0714 26 Apr 69	19.94	36° 47.98'N 121° 51.58'W	366	The current meter chart recorder had blank periods indicating no data had been recorded. The record was broken into the intervals indicated in the far left column and each period containing data was handled as a separate record.
1038 26 Apr 69 to 1357 26 Apr 69	3.37			
1533 26 Apr 69 to 0052 27 Apr 69	9.32			
0148 27 Apr 69 to 0033 3 May 69	142.75			

V. DATA ANALYSIS

A. DATA SAMPLING AND REDUCTION OF CURRENT RECORD PROCEDURES

The Hydro Products current meter provided a record of current speed and direction and water temperature. These records were digitized at a sampling interval of 3.75 minutes. Since the temperature was recorded every 7.5 minutes, the intermediate values were interpolated. The current meter data was processed on the NPS Computer Facility IBM 360 computer using programs discussed in section C of this chapter.

B. SAMPLING PROCEDURE AND DATA REDUCTION OF TIDAL RECORDS

The marigrams for the observational periods were digitized using a Calma Company Model 480 digitizer at the Pt. Pinos Annex of the Fleet Numerical Weather Central (FNWC). PROGRAM CONVERT (Appendix F) was used on the FNWC CDC 6500 computer to convert the digitized information stored on magnetic tape to punched computer cards. Procedures for digitizing the records are outlined in Appendix A of Robinson [1969]. The sampling interval of the digitizer was 0.01 inch; however, for this investigation, only every 0.07 inch was printed as output and punched onto computer cards giving a sampling interval of approximately 3.86 minutes. These data were then input to PROGRAM TIDE (Appendix G) which provided a graph of tidal fluctuations.

C. ELEMENTARY STATISTICS

First order statistics for the current meter records were computed using standard techniques in PROGRAM CURRENT (Appendix H) written by Dooley [1968] and modified by Njus [1968]. A transformation of current direction suggested by Webster [1964a] was employed to facilitate the computations for direction.

PROGRAM CURRENT provides:

(1) Hourly means
(2) Daily means, medians, modes and frequency distribution
(3) Time series means, medians, modes, variances, standard deviations and frequency distribution
(4) Graphic histograms.

PROGRAM COMPOSITE DRAW (Appendix I) was used to give a graphic display of current speed, current direction and water temperature. This program was modified to PROGRAM TEMPERATURE DRAW (Appendix J) to give a better display of temperature.

D. POWER SPECTRA ANALYSIS

Power Spectra analysis was performed on all the available records of sufficient length using programs originally developed at the Institute of Oceanography of the University of British Columbia (UBC). The UBC system consists of three programs: FTOR, SCOR and FCPLOT (Appendix K). The data is initially read onto a magnetic tape using the following program:

```
C     CARD TO TAPE FOR TIME SERIES PROGRAMS
C
      DIMENSION TEMP(5), SPEED(5), DIR(5)
      JCTR = 15
      NCHANS = 3
   10 READ (5,2001, END=20) (TEMP(I),SPEED(I),DIR(I),I=1,5)
      WRITE (6,100) JCTR, NCHANS, (TEMP(I),SPEED(I),DIR(I),I=1,5)
  100 FORMAT (2I5,15F8.2)
      GO TO 10
   20 END FILE 4
      REWIND 4
 2001 FORMAT (5(F5.1,F5.2,F4.0))
      END
```

Data blocks of 2^n points, where n is a positive integer less than or equal to 13, can be used and two or more blocks are required. After the data has been read onto the tape, FTOR computes the Fourier coefficients for the time series and writes them on another tape. SCOR then reads the output of FTOR and computes spectrum, cospectrum and quadrature spectrum for the series. FCPLOT is used to give a Calcomp plot of the spectrum. These procedures are described in greater detail by Wilson, et al, [1969].

VI. DISCUSSION

A. GRAPHIC PLOT AND STATISTICAL ANALYSIS

Plots from programs COMPOSITE DRAW, TEMPERATURE DRAW and TIDE are shown in Appendix B. Figures 24 through 27 are for the 300-ft 91-meter array located on the north shelf of the Canyon on 11 April 1969 while results from the 1200-ft 366-meter array in the Canyon of the same date are shown in Figures 28 to 31. These are the first simultaneous records of near-bottom currents in Monterey Submarine Canyon and on the adjacent shelf. In the shelf record, the general flow is to the southeast, into the Canyon, particularly on the rising tide. At high tide and for a few hours into falling tide the flow fluctuates, sometimes changing to a northerly direction. Speeds are quite low, seldom over 11 cm/sec, and the highest speeds occur near high tide.

In contrast with the shelf record, records from the Canyon for the same period show that falling tide is associated with up-canyon flow and rising tide with down-canyon flow. This oscillatory flow has been observed in previous studies in the Canyon. Maximum speeds reached in the Canyon were in excess of 35 cm/sec and usually occurred with down-canyon flow, although this was not always the case.

The 366-meter array of 25 April 1969 is shown in Figures 32 through 37. The direction is nearly constant at 165°T. Blank spaces in the record indicate periods of no data on the strip-chart recorder. Dooley [1968] reported a single mode for a record collected on 24 November 1967 at a depth of 128 meters in the Canyon. His record covered only a 56-hour period and no further discussion was given to explain this anomaly. Undoubtedly, local irregularities in the bottom topography of the Canyon could cause variations from the expected; however, for this record, it is felt that the current meter was not properly recording direction. The speed record for the 25 April record shows that maximum speeds normally occur at high tide as seen in the shallow record of 11 April. Speeds often reach 51.5 cm/sec and remain over 25 cm/sec for several hours. The speeds build rapidly to a maximum and then gradually decrease to a minimum.

Figures 6 through 11 show the frequency distributions computed by PROGRAM CURRENT of temperature, current speed and current direction. Table II summarizes the elementary statistics for records from the 91- and 366-meter arrays set simultaneously on 11 April 1969 and the 366-meter array of 25 April 1969. Histograms for the arrays placed at 91 and 366 meters are shown in Figures 6 and 7 respectively. At 91 meters, the speed is unimodal with no values over 25 cm/sec and direction is scattered with a predominate peak between 105 and 155°T. Mean speed and direction for this observation are 6.7 cm/sec and 137°T, with standard deviations of 2.6 cm/sec and 63.7°. The 366-meter array shows that current speed and direction exhibit characteristics similar to those previously observed in Monterey Submarine Canyon by Dooley and Njus. Speeds range from zero to greater than 25 cm/sec and current direction is bimodal with the modes approximately 180° apart. Mean speed and direction are 10.8 cm/sec and 156°T, while standard deviations are calculated to be 7.2 cm/sec and 89.6°.

Histograms from the 366-meter array of 25 April 1969 are shown in Figures 8 through 11. For the first 38½ hours of the record, speed remains less than 25 cm/sec; however, for the portion starting at 0148 on the 27th of April speeds of 51.5 cm/sec are observed.

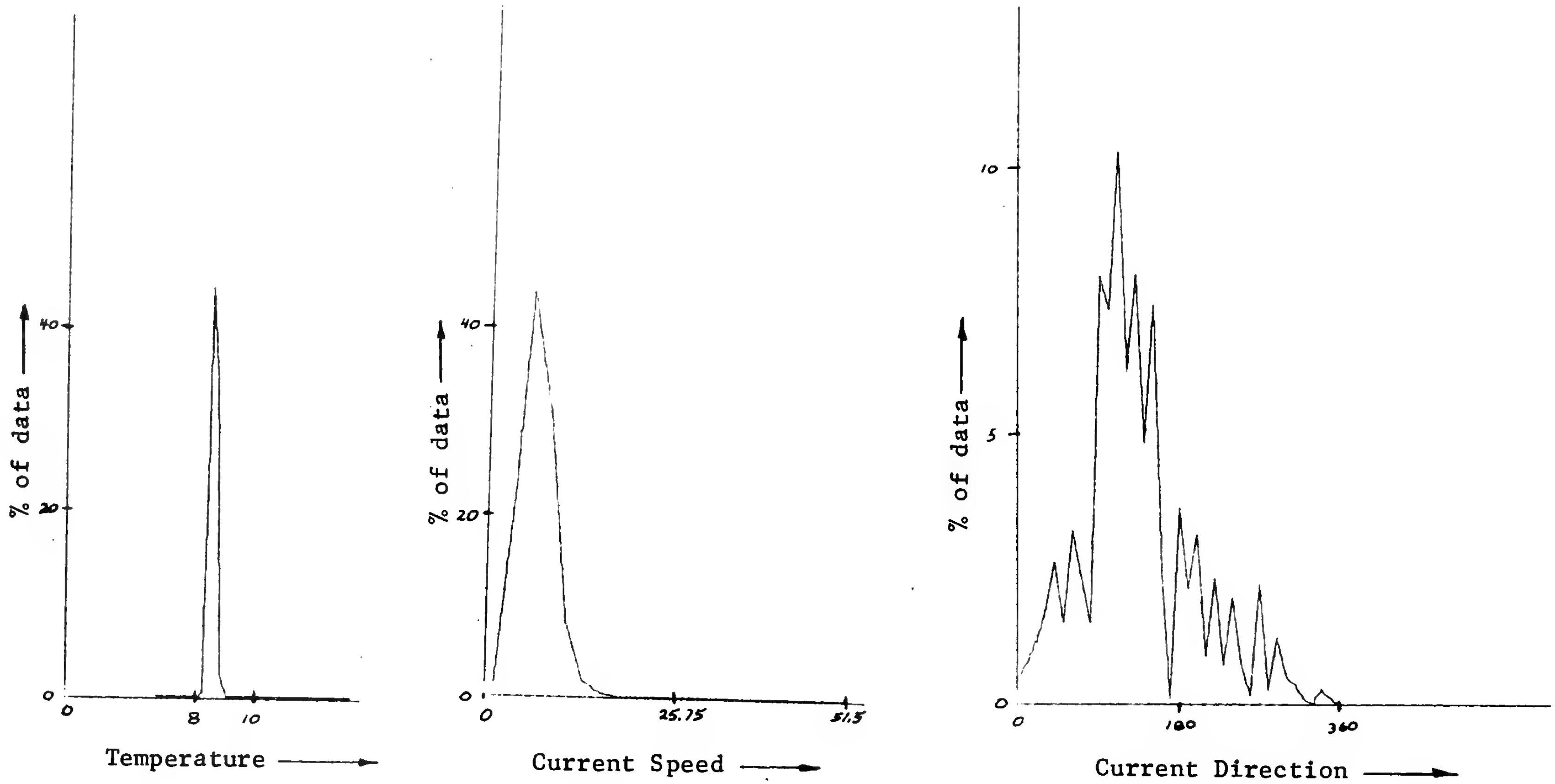


Figure 6. 1148 11 April to 1503 18 April 1969 Frequency Distributions

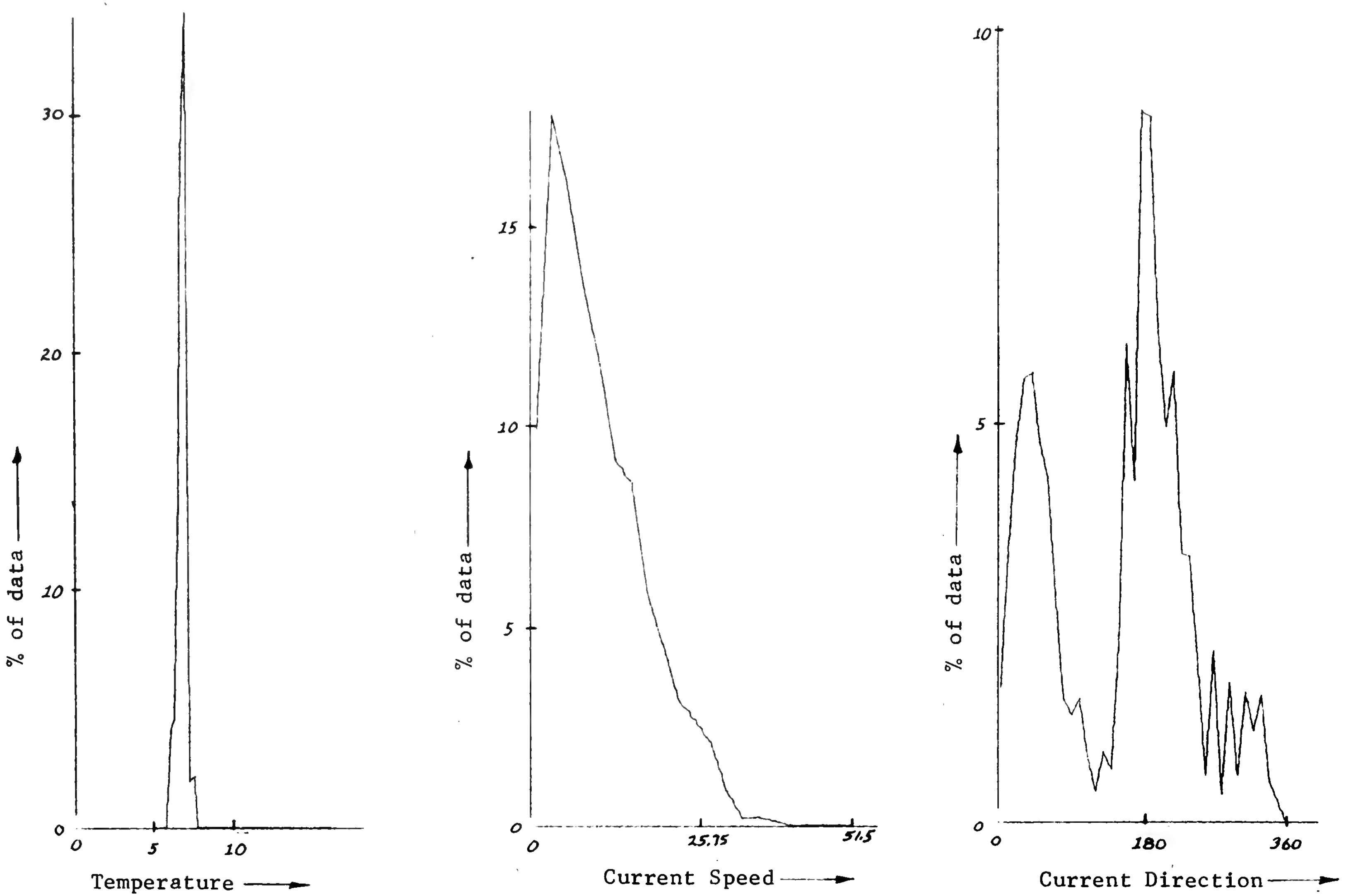


Figure 7. 1215 11 April to 1149 18 April 1969 Frequency Distributions

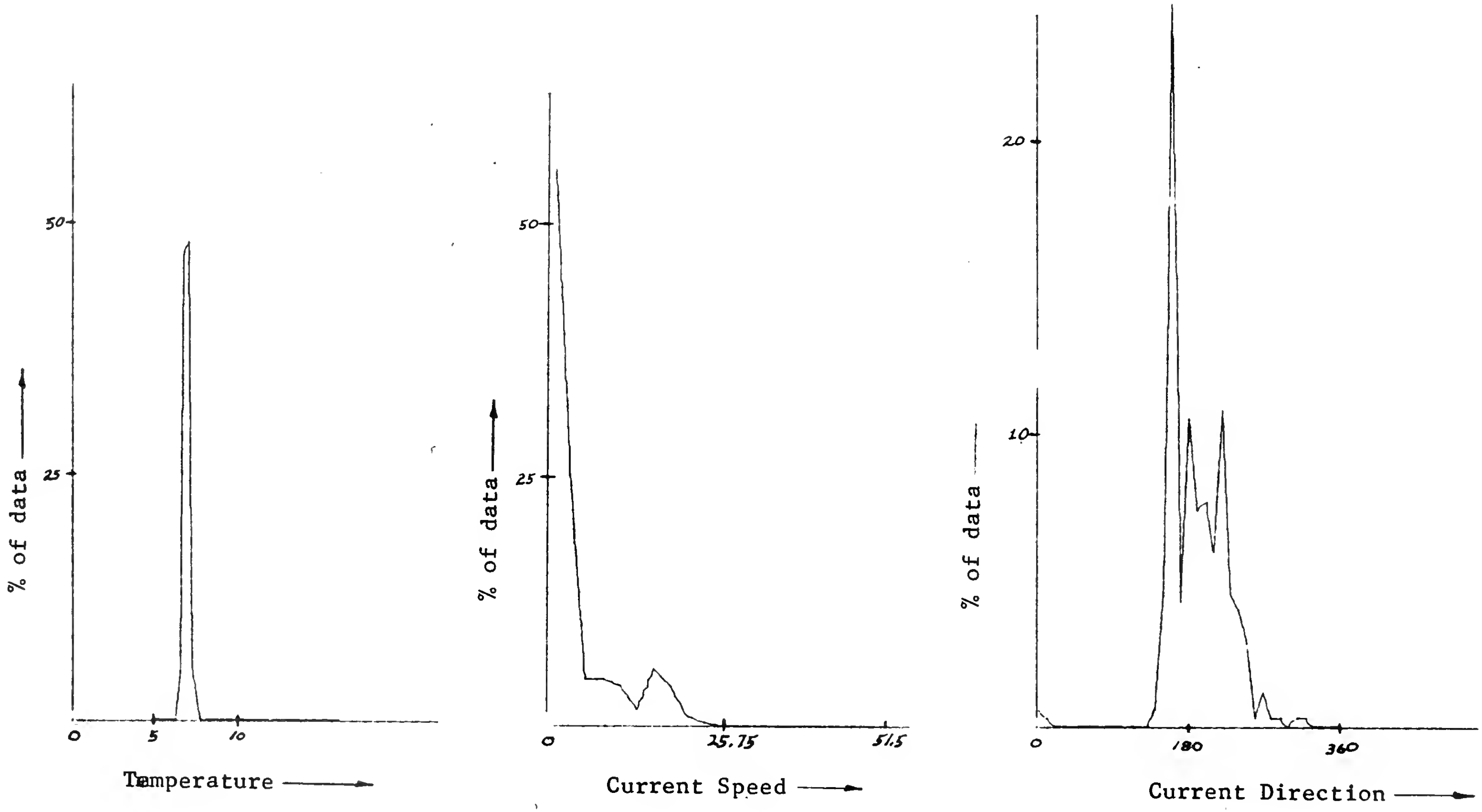


Figure 8. 1118 25 April to 0714 26 April 1969 Frequency Distributions

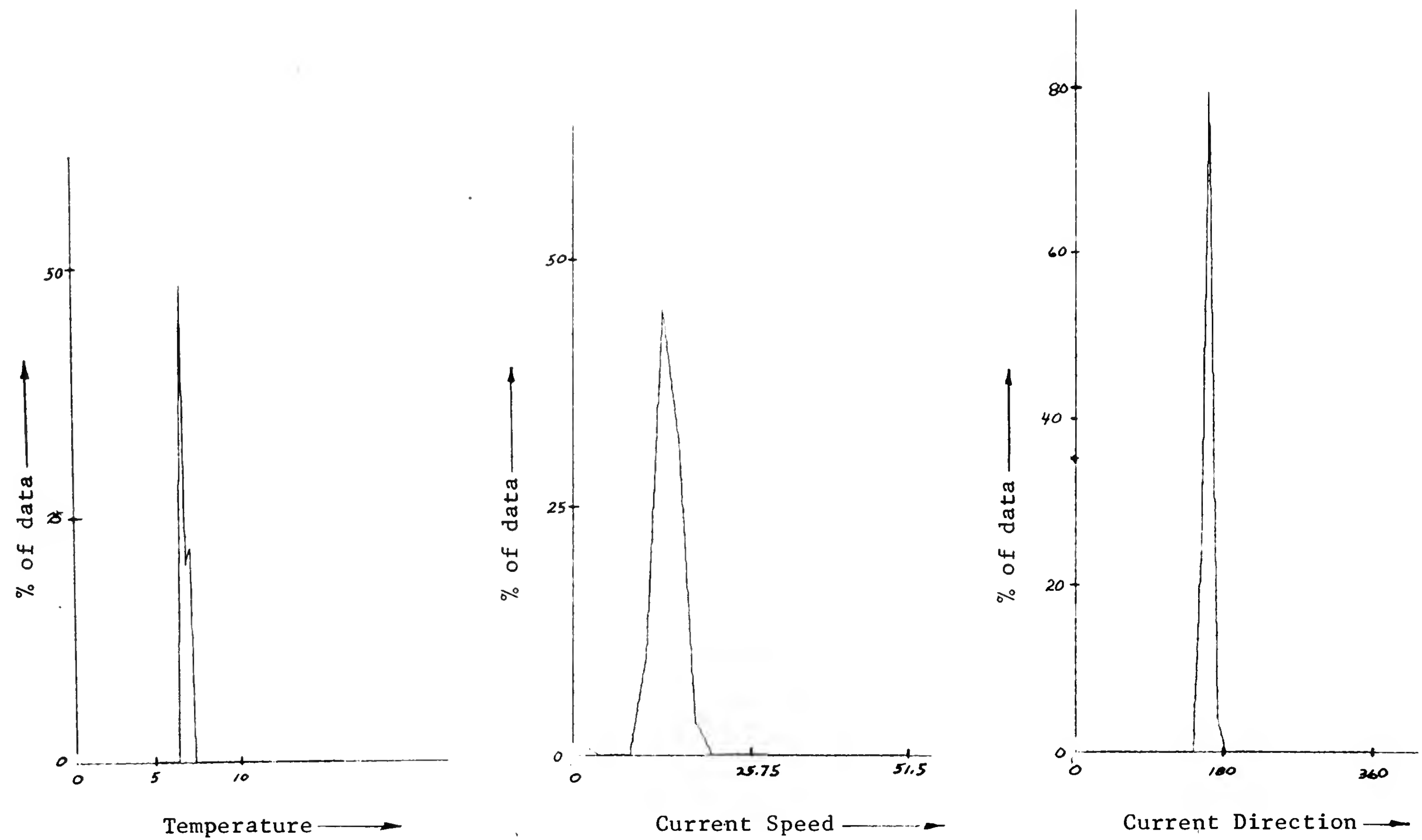


Figure 9. 1038 26 April to 1357 26 April 1969 Frequency Distributions

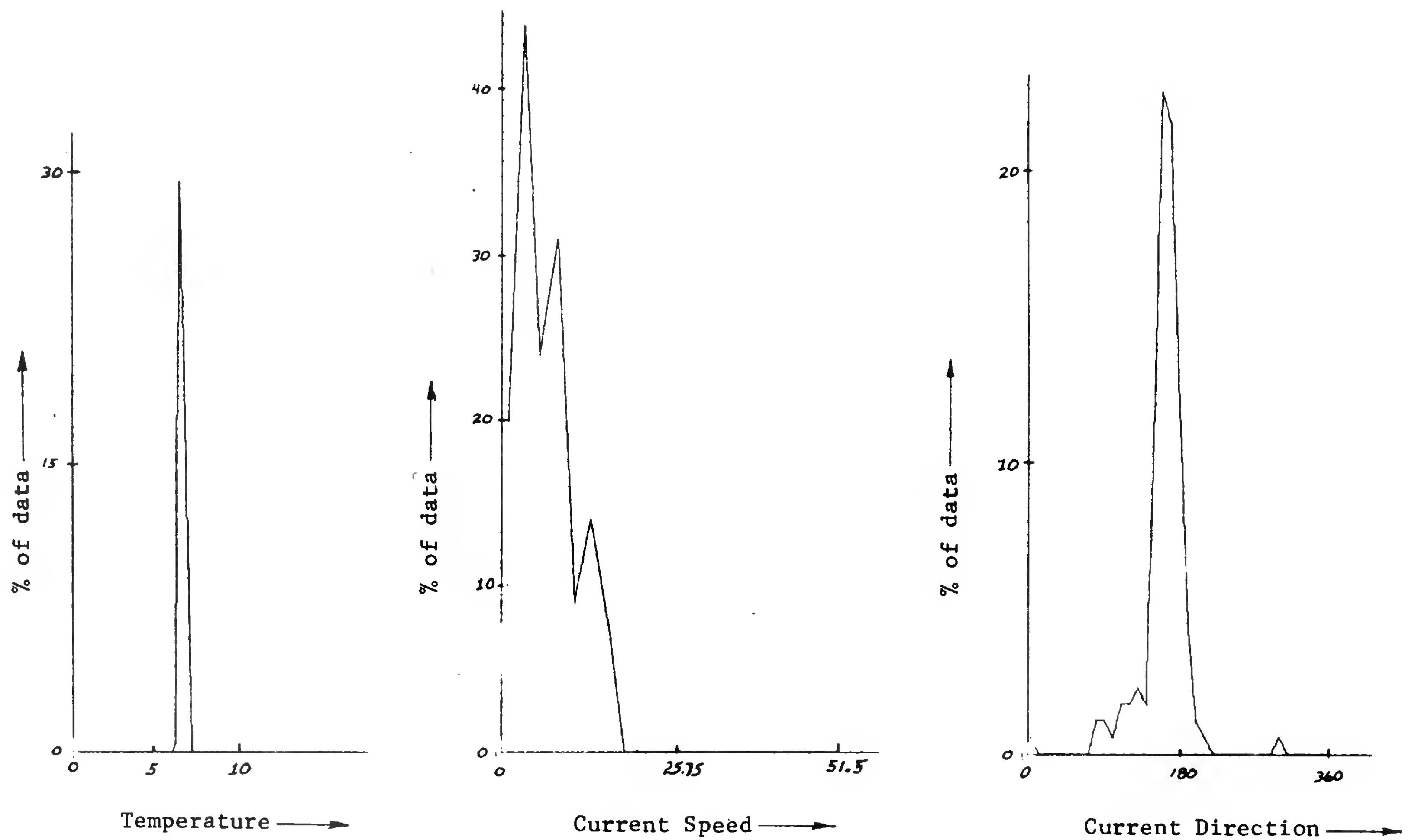


Figure 10. 1533 26 April to 0052 27 April 1969 Frequency Distributions

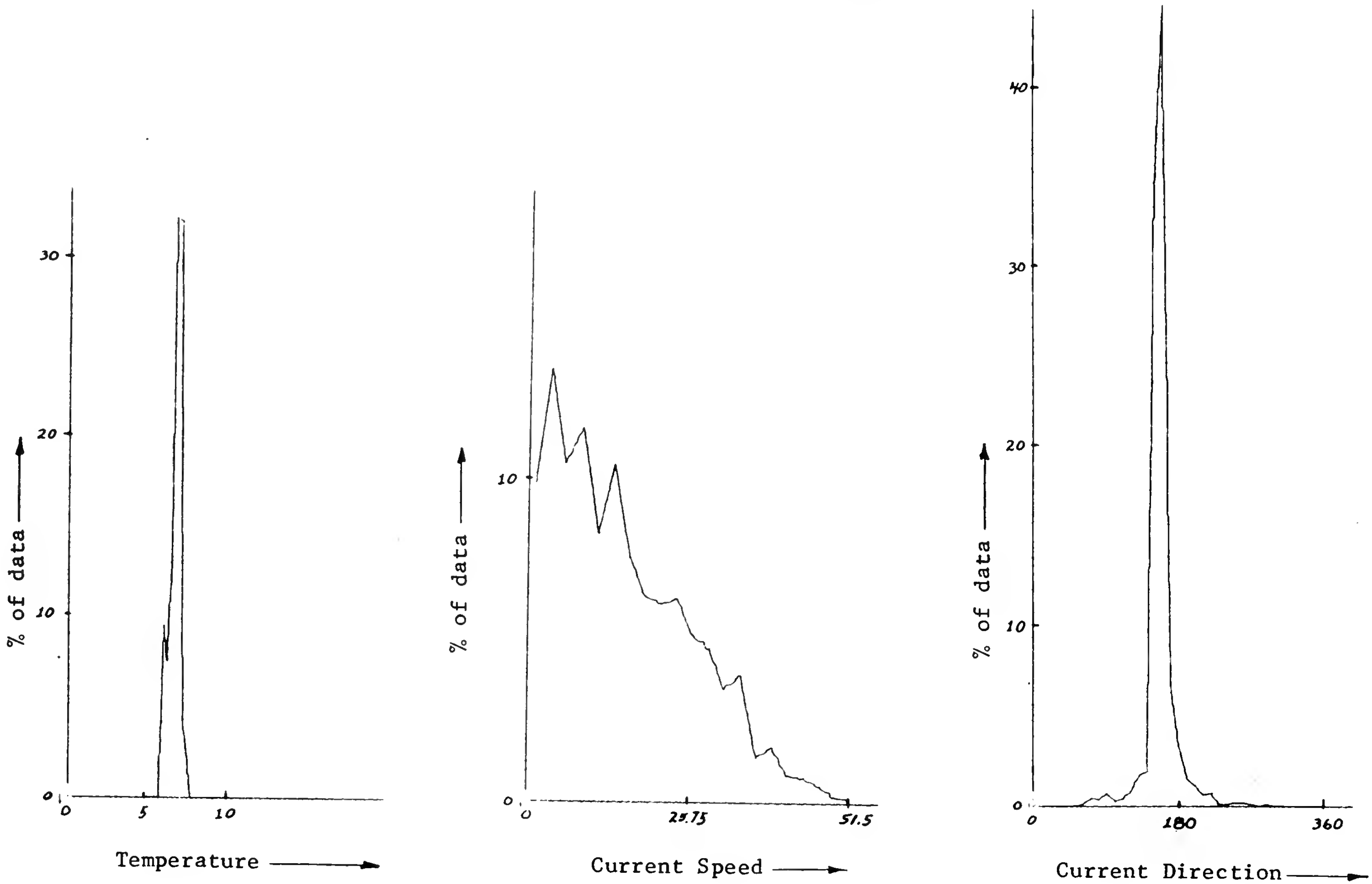


Figure 11. 0148 27 April to 0033 3 May 1969 Frequency Distributions

TABLE II

SUMMARY OF CURRENT STATISTICS

START/FINISH TIME (Local)		WATER TEMPERATURE	CURRENT SPEED	CURRENT DIRECTION
1148 11 April to 1503 18 April 1969	Mean	8.38°C	6.67 cm/sec	132°T
	Variance	0.04(°C)^2	6.59(cm/sec)^2	4057(°T)^2
	Standard Deviation	0.19°C	2.57 cm/sec	63.2°T
	Median	8.40°C	6.2 cm/sec	130°T
	Mode	8.45°C	7.7 cm/sec	115°7
1215 11 April to 1149 18 April 1969	Mean	6.86°C	10.8 cm/sec	156°T
	Variance	0.07(°C)^2	51.1(cm/sec)^2	8033.5(°T)^2
	Standard Deviation	0.27°C	7.16 cm/sec	89.6°T
	Median	6.90°C	10.3 cm/sec	180°T
	Mode	7.12°C	4.12 cm/sec	190°T
1118 25 April to 0714 26 April 1969	Mean	6.96°C	4.12 cm/sec	196°T
	Variance	0.03(°C)^2	32.1(cm/sec)^2	1252(°T)^2
	Standard Deviation	0.16°C	5.67 cm/sec	35.4°T
	Median	7.00°C	2.08 cm/sec	190°T
	Mode	7.12°C	1.55 cm/sec	165°T
1038 26 April to 1357 26 April 1969	Mean	6.73°C	14.95 cm/sec	164°T
	Variance	0.04(°C)^2	4.24(cm/sec)^2	19(°T)^2
	Standard Deviation	0.19°C	2.06 cm/sec	4.4°T
	Median	6.70°C	13.9 cm/sec	165°T
	Mode	6.63°C	15.5 cm/sec	165°T
1533 26 April to 0052 27 April 1969	Mean	6.67°C	6.70 cm/sec	166°T
	Variance	0.03(°C)^2	21.4(cm/sec)^2	582(°T)^2
	Standard Deviation	0.16°C	4.63 cm/sec	24.2°T
	Median	6.80°C	5.66 cm/sec	168°T
	Mode	6.75°C	4.12 cm/sec	170°T
0148 27 April to 0033 3 May 1969	Mean	6.82°C	15.4 cm/sec	162°T
	Variance	0.11(°C)^2	108.2(cm/sec)^2	398(°T)^2
	Standard Deviation	0.33°C	10.8 cm/sec	19.9°T
	Median	6.87°C	13.9 cm/sec	162°T
	Mode	7.08°C	5.15 cm/sec	165°T

Direction is markedly constant and is believed to be in error. Mean speed and current direction for the longest portion of the record is 15.4 cm/sec and 162°T with standard deviations of 10.8 cm/sec and 19.9°. These compare to a mean of 10.8 cm/sec and 156°T for the 11 April array at the same depth. Tidal range for the last 80 hours of the 25 April 366-meter array is much higher than for the 11 April array at the same location. This may account for the higher speeds reported for the 25 April array. Dooley's and Njus' time-series data revealed this effect in isolated cases.

Temperatures for all records show narrow unimodal peaks with the shallower record having warmer waters as expected. Means for the simultaneous 91- and 366-meter arrays are 8.4 and 6.9°C with standard deviations of 0.2 and 0.3°C. For the 366-meter array on 25 April, the mean is 6.8°C with the standard deviation being 0.3°C.

B. PROGRESSIVE VECTOR DIAGRAM

A progressive vector diagram (PVD) is one graphic method of showing a time series of current velocity. The diagram is constructed by adding successive current vectors. As stated by Webster [1964b], the temptation is to think of the diagram as representing the path of a particle's trajectory; however, this can be misleading, since the PVD represents particle trajectory only when the field of motion is independent of position over the spatial scale. This seldom occurs in nature, particularly in shallow water.

PROGRAM VECTOR DIAGRAM (Appendix L) was written to (1) provide a PVD from the hourly values calculated by PROGRAM CURRENT and (2) calculate the volume transport at the array location. A scatter diagram (SD) of the velocity vectors was obtained to compliment the

PVD using the PLOTP subroutine available in the NPS computer program library. These presentations are new to the analysis of Monterey Submarine Canyon current data. Because of this fact, the data collected by Njus and Dooley are also analyzed and presented in Appendix C and D.

The scatter diagrams of the data collected in this investigation are shown in Figures 12 through 14. The first SD is for the 91-meter array of 11 April. It shows the predominate mode towards the southeast. Figure 13, for the 366-meter array of 11 April, shows the expected bimodal tendency of currents in the Canyon; however, both northeastward and southwestward modes are skewed towards a southerly direction. The longest portion of the 25 April 366-meter array is shown in Figure 14.

The progressive vector diagrams for the same data are shown in Figures 15 to 18. Successive 24-hour periods are marked with a "X." Figure 15 is the PVD for the shelf record and Figure 16 is for the Canyon record of the same date. Both of these figures show very clearly a feature of the Canyon circulation not previously reported. The PVD from the deeper array shows the cyclic up-canyon and down-canyon flow previously reported but also a net set to the southeast across the Canyon. As expected from the SD of the shelf array, the net current set is also southeast into the Canyon. The combination of the two simultaneous arrays are shown in Figure 17. The net set for both sites is to the southeast, particularly for the first $3\frac{1}{2}$ days of the record. Since the Canyon axis for the 366-meter site is 085-265°T, the set is cross canyon..

For the period of these observations, winds in the Monterey Bay area were very strong from the west to northwest. This would cause

Scatter Diagram

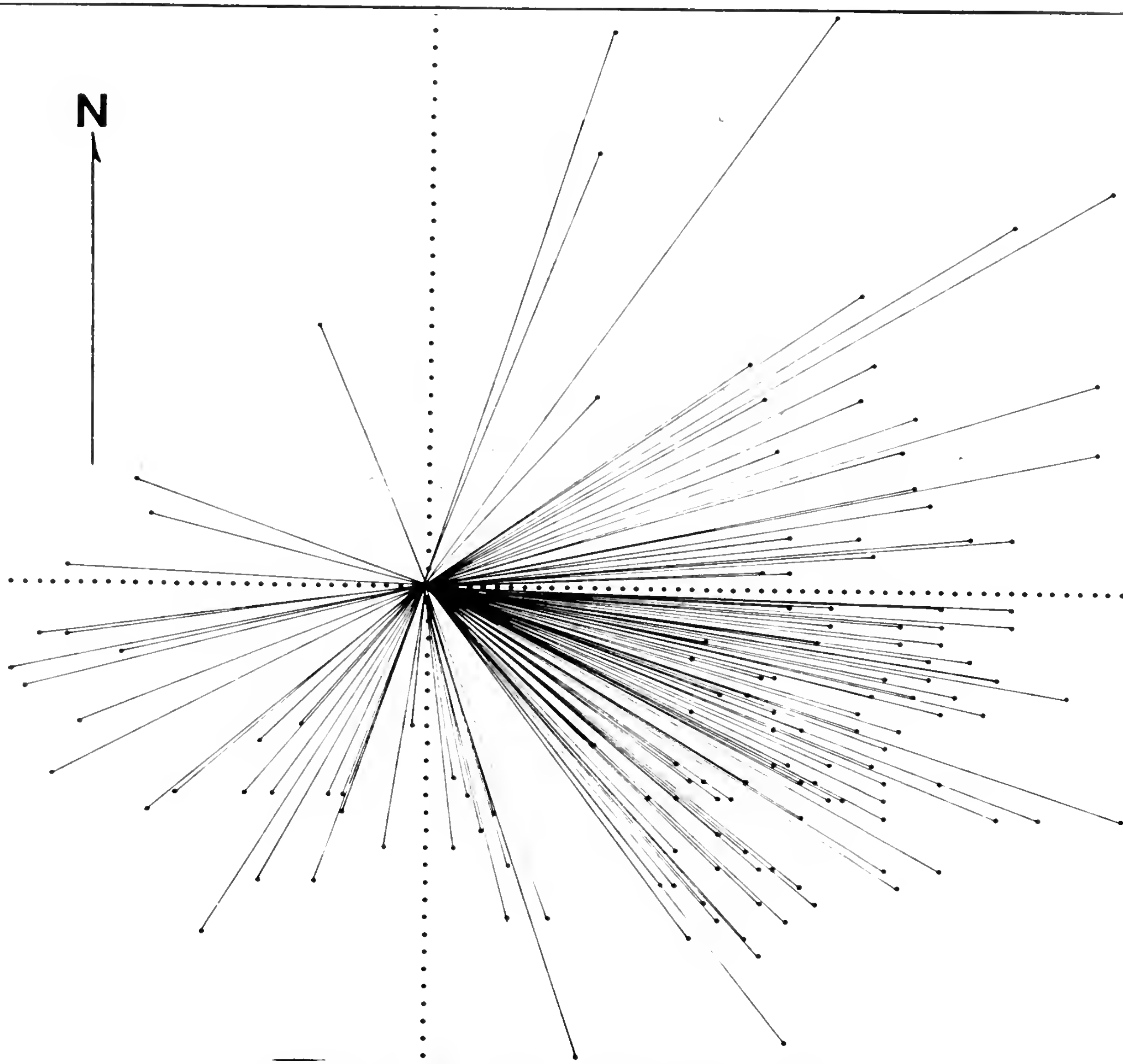


Figure 12. 1148 11 April to 1503 18 April 1969

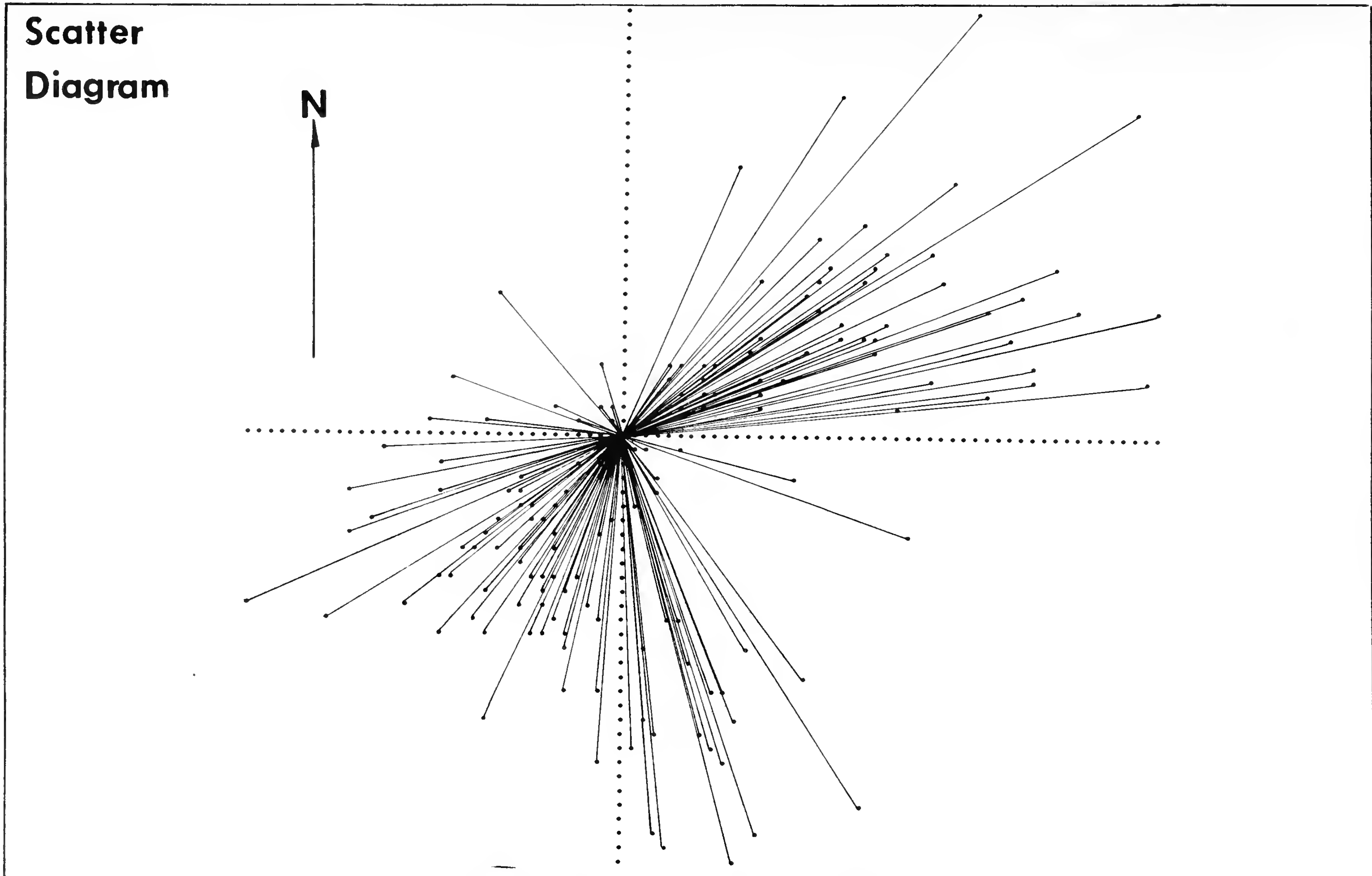


Figure 13. 1215 11 April to 1149 18 April 1969

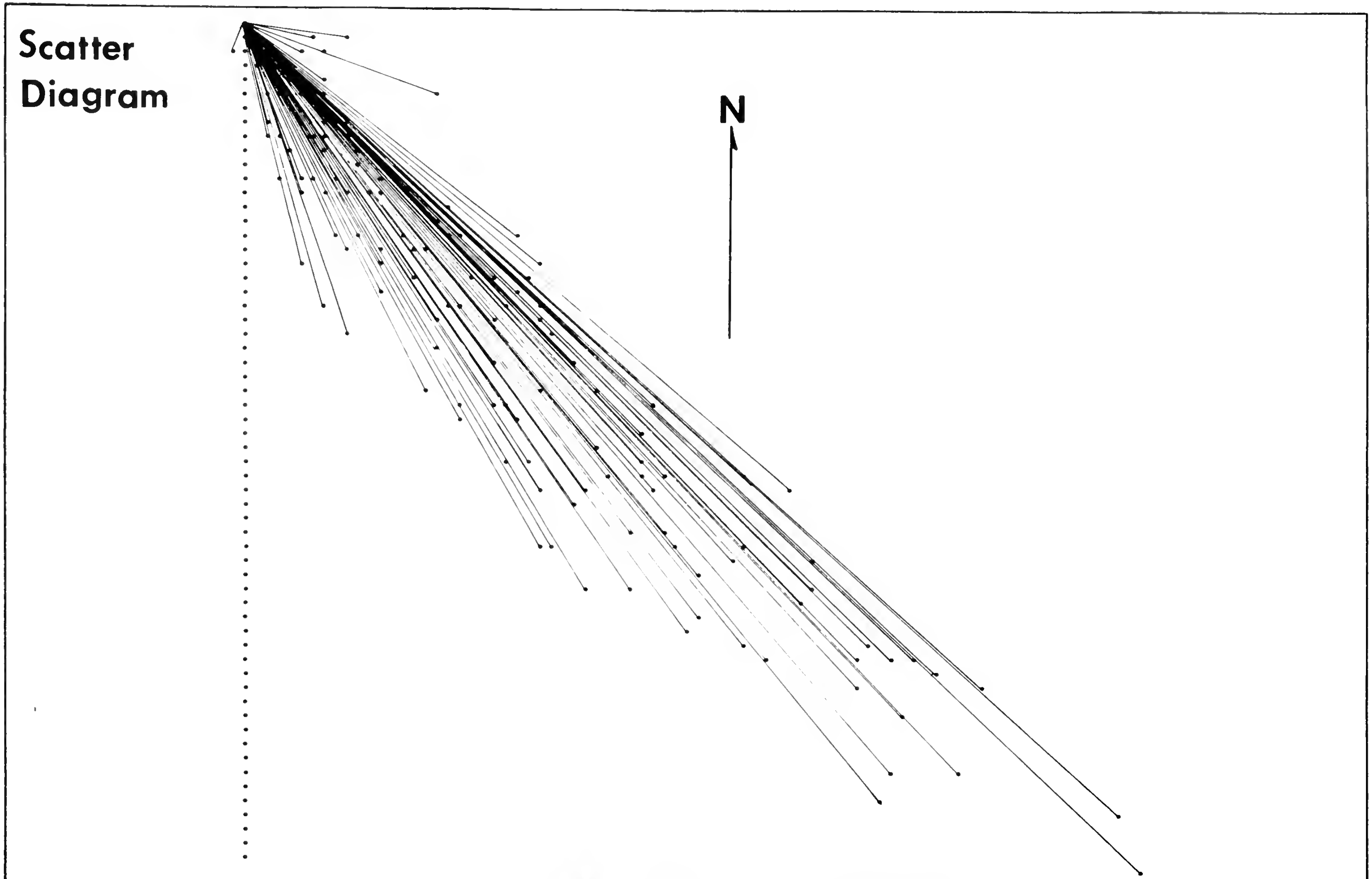


Figure 14. 0148 27 April to 0033 3 May 1969

a longshore current to the south in the Bay. The bottom topography of the Canyon near the 91-meter array (Figure 5) would funnel the south-flowing longshore current into the Canyon in a cross-canyon direction. While the cyclic up-canyon and down-canyon tidal currents would persist, this inflow from the north could cause the 366-meter array in the Canyon to exhibit a net set toward the south.

The PVD (Figure 18) for the 366-meter array of 25 April also shows a southeastward set. As mentioned before, this record is believed to be in error; however, it is interesting to note that the net set shown is in the same general direction as the set from the earlier array at this depth.

Dooley's and Njus' records of SD are shown in Appendix C (Figures 38 to 44). The PVDs of their records are shown in Appendix D (Figures 45 to 51) and display the net current set for the periods of observation. Njus' record of 26 September 1968 (Figure 46) at a depth of 160 meters shows the cyclic tidal fluctuations and the net current set to the southeast as do the records of this investigation. The remainder of their records, however, show various directions of set.

Total volume transport for each array was calculated and divided by the number of hours each array recorded data, giving volume transport in cubic meters per hour. A summary of net current set and volume transport for all records is given in Table III. These volume transports and current sets are plotted in Figure 19 as a function of months in an attempt to relate the current set and volume transport to the ocean seasons of the Monterey Bay as defined by Skogsberg [1936]. The volume transport and net current set for the 25 April 1969 record was not plotted because as previously discussed, this record is in question.

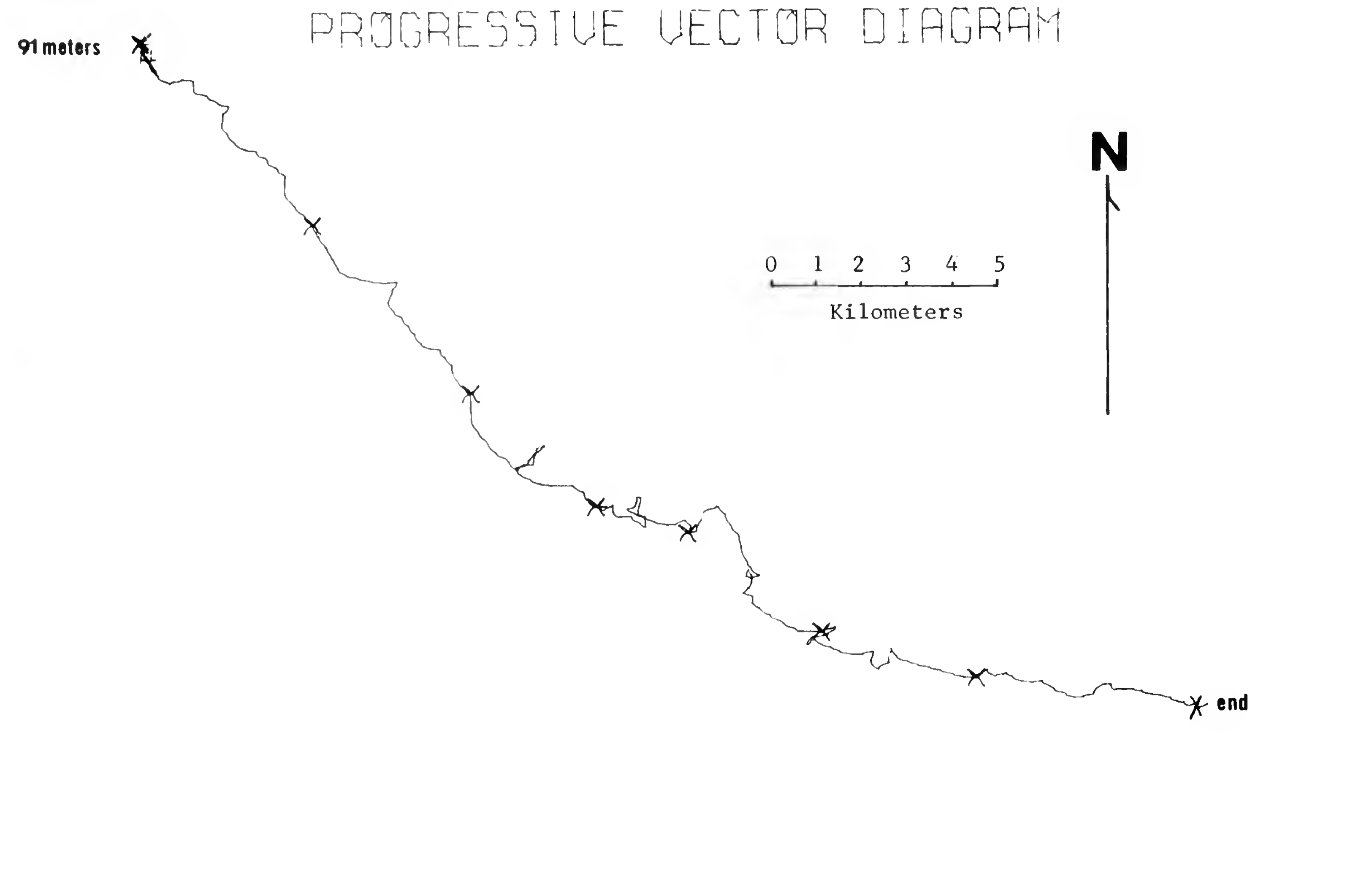


Figure 15. 1148 11 April to 1503 18 April 1969

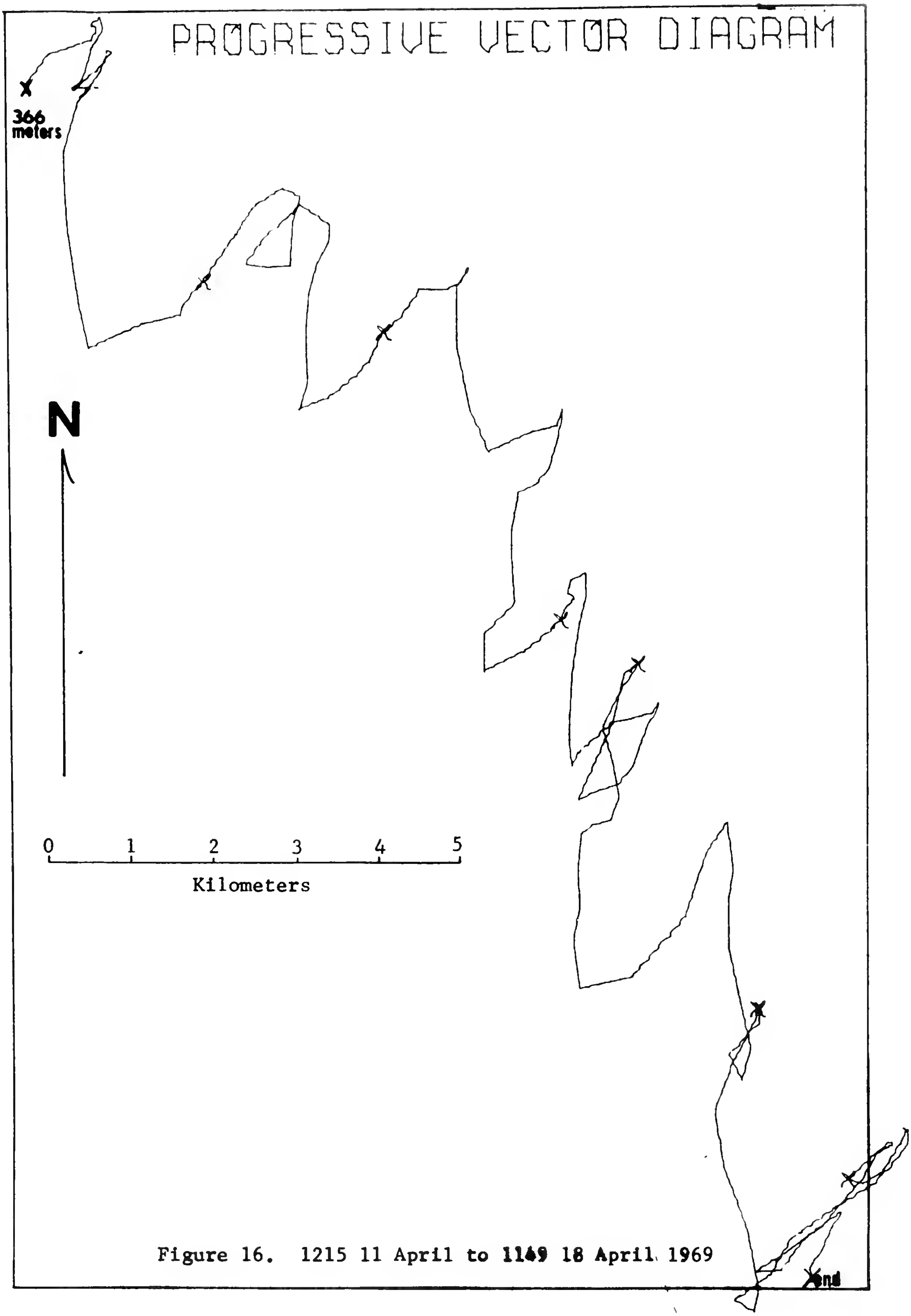


Figure 16. 1215 11 April to 1149 18 April 1969

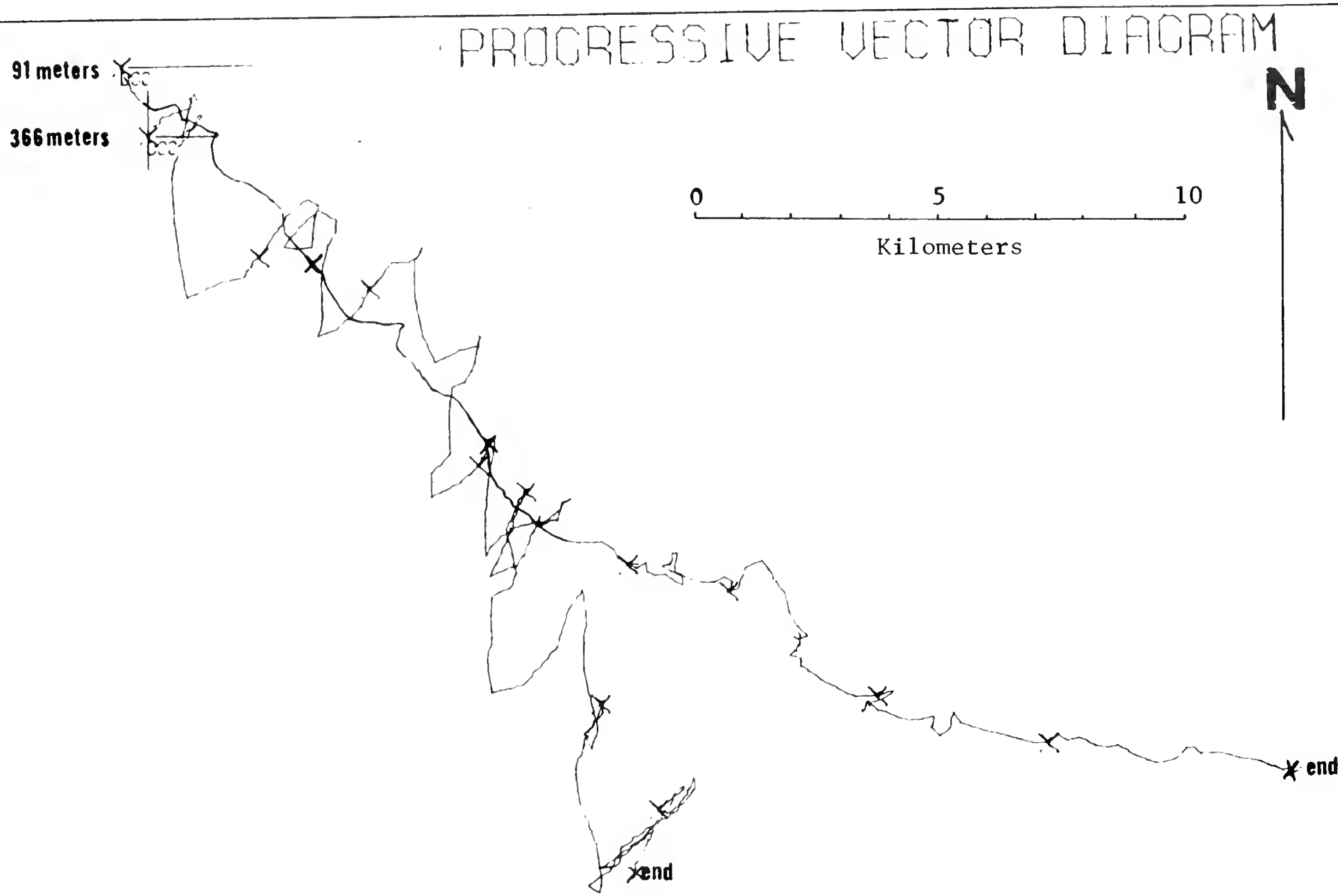


Figure 17. Simultaneous 91- and 366-meter Arrays

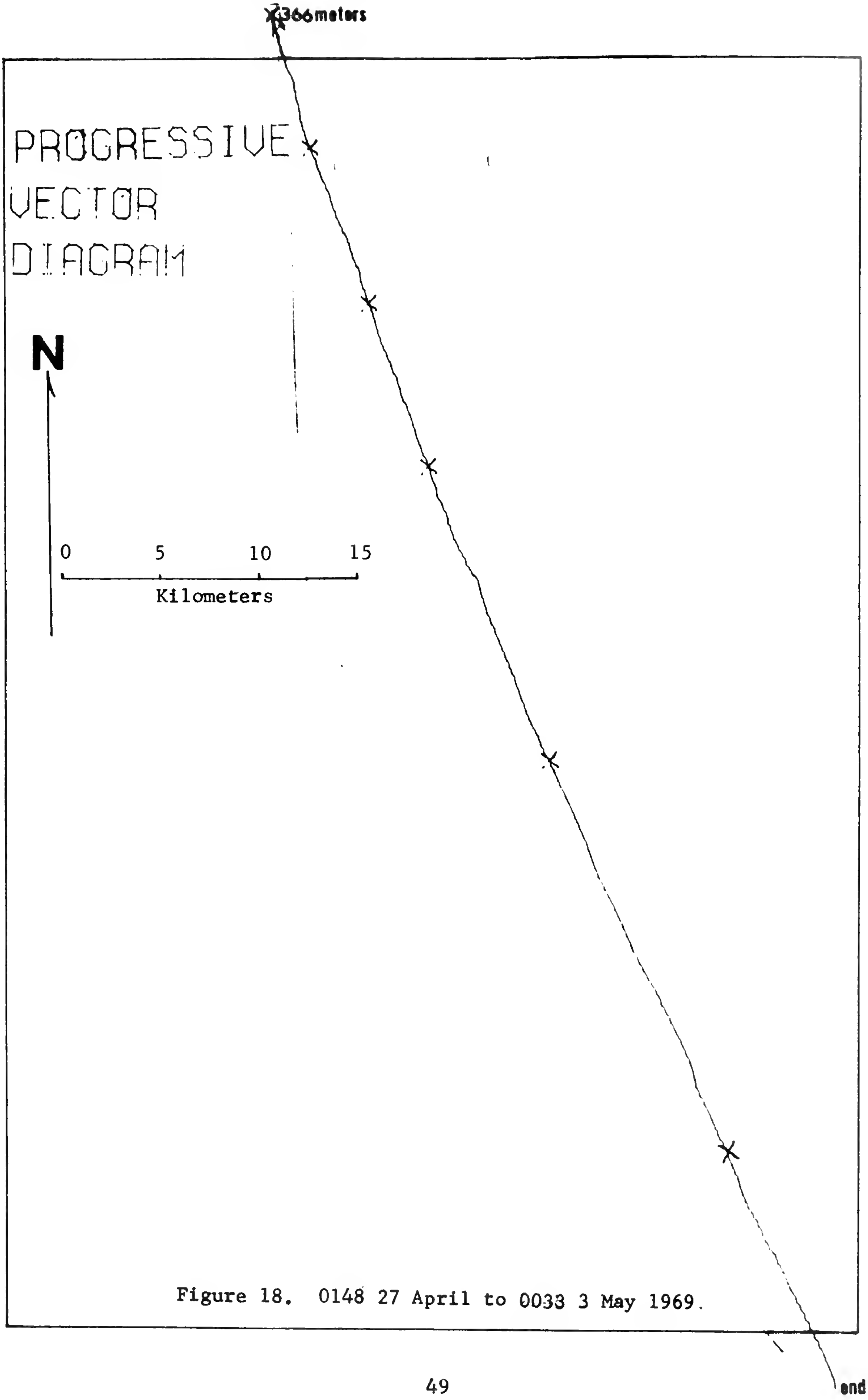
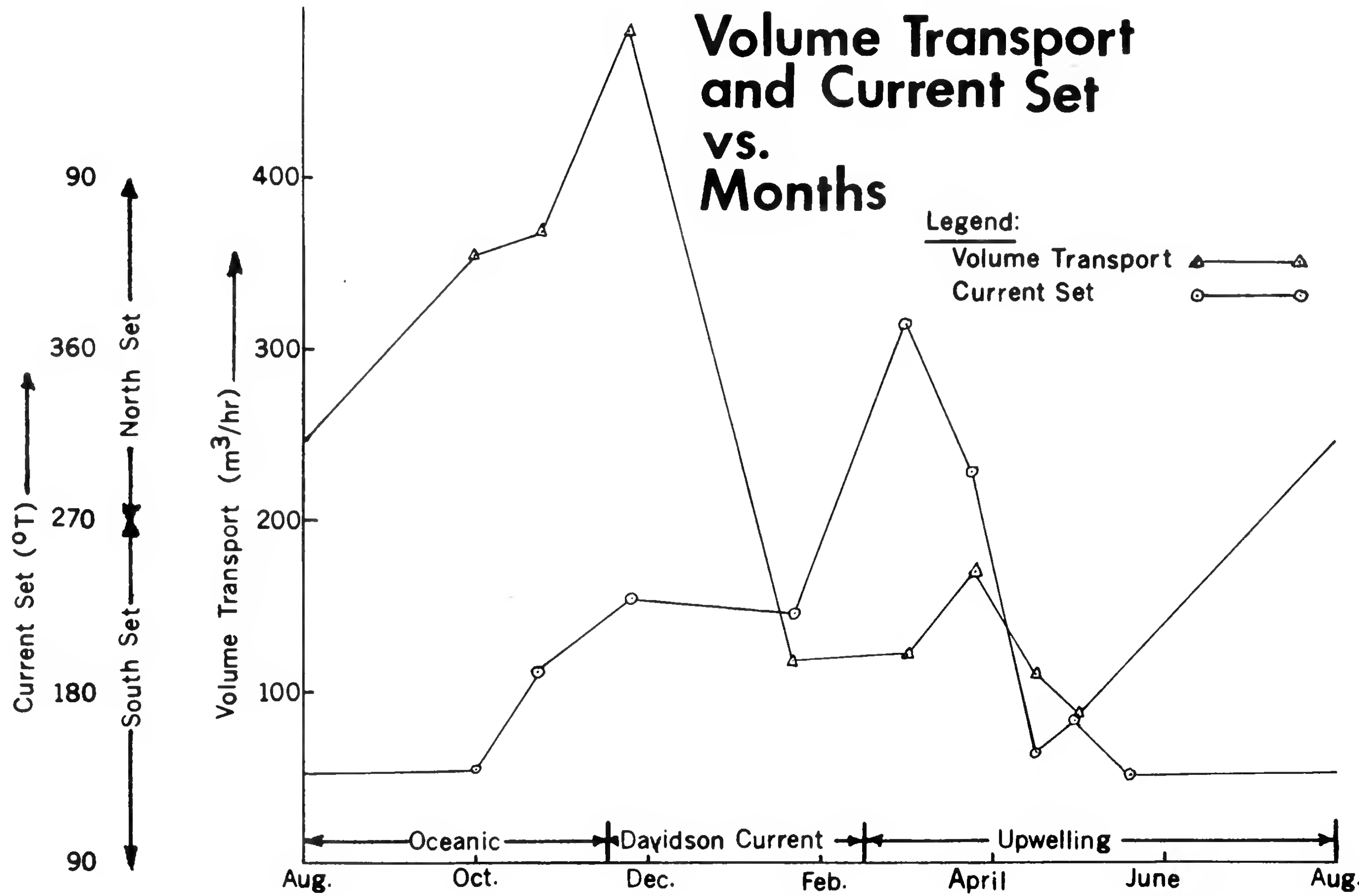


Figure 18. 0148 27 April to 0033 3 May 1969.



Volume Transport
and Current Set
vs.
Months
Legend:
Volume Transport
Current Set
Current Set (°T)
90
360
270
180
90
North Set
South Set
Volume Transport (m³/hr)
400
300
200
100
Oceanic
Davidson Current
Upwelling
Aug.
Oct.
Dec.
Feb.
April
June
Aug.

Figure 19.

TABLE III

SUMMARY OF RESULTS OF PROGRAM VECTOR DRAW

Figure Number	Date (Start of Record)	Depth (Meters)	Net Current Direction Set ($^\circ T$)	Volume Transport (Meters^3/Hour)
45	1000 22 March 1967	119	294	171
46	1110 24 November 1967	128	228	486
47	1426 15 January 1968	133	222	117
48	1010 29 February 1968	165	011	122
49	1507 14 May 1968	104	138	85
50	1230 26 September 1968	160	140	355
51	1050 17 October 1968	202	190	369
15	1148 11 April 1969	91	121	168
16	1215 11 April 1969	366	147	110
18	0148 27 April 1969	366	160	548

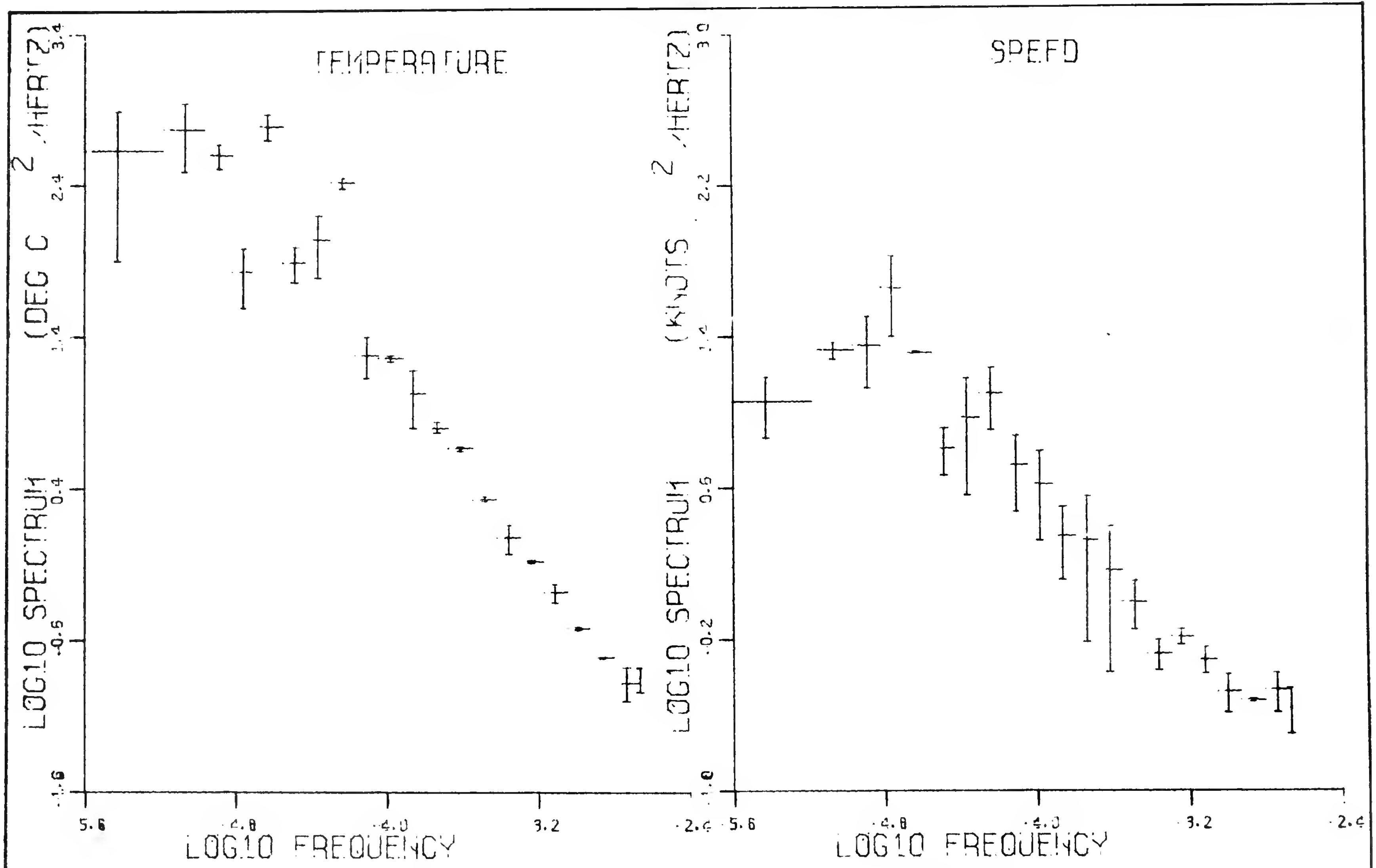
Current set is predominately south for the oceanic period and the latter part of the upwelling period. North set is observed for the transition between the Davidson Current and upwelling periods. Although the set would be expected to be northerly during the Davidson Current period and southerly for the oceanic and upwelling periods, the dividing line between the seasons is not well defined and during the periods reported in this investigation, set in the Canyon was to the south during the Davidson Current period.

Volume transport changes significantly from the oceanic to the Davidson Current period and through the upwelling period. Transports of approximately 400 m^3/hr are seen toward the latter part of the oceanic period and then decrease to less than 200 m^3/hr during the remaining two seasons.

C. SPECTRAL ANALYSIS

Spectral estimates of temperature and speed for the records collected during this investigation are shown in Figures 20 to 22. Figure 23 can be used to convert $\log_{10}$ frequency to the period in hours. The short portions of the 25 April 1969 record were not analyzed.

For the 91-meter array, temperature peaks occurred at 34.5, 12 and 5 hours and speed peaks at 16, 5 and 0.5 hours. The 366-meter array on the same date shows periods of 31.5 and 12 hours for temperature and 35, 16 and 5 hours for speed. For the longer portion of the 25 April 366-meter array, periods of 12 and 7 hours for temperature and 22.75, 11 and 7 hours for speed are observed. The consistent peak at 12 hours is obviously tidal.



'Figure 20. 1148 11 April to 1503 18 April 1969

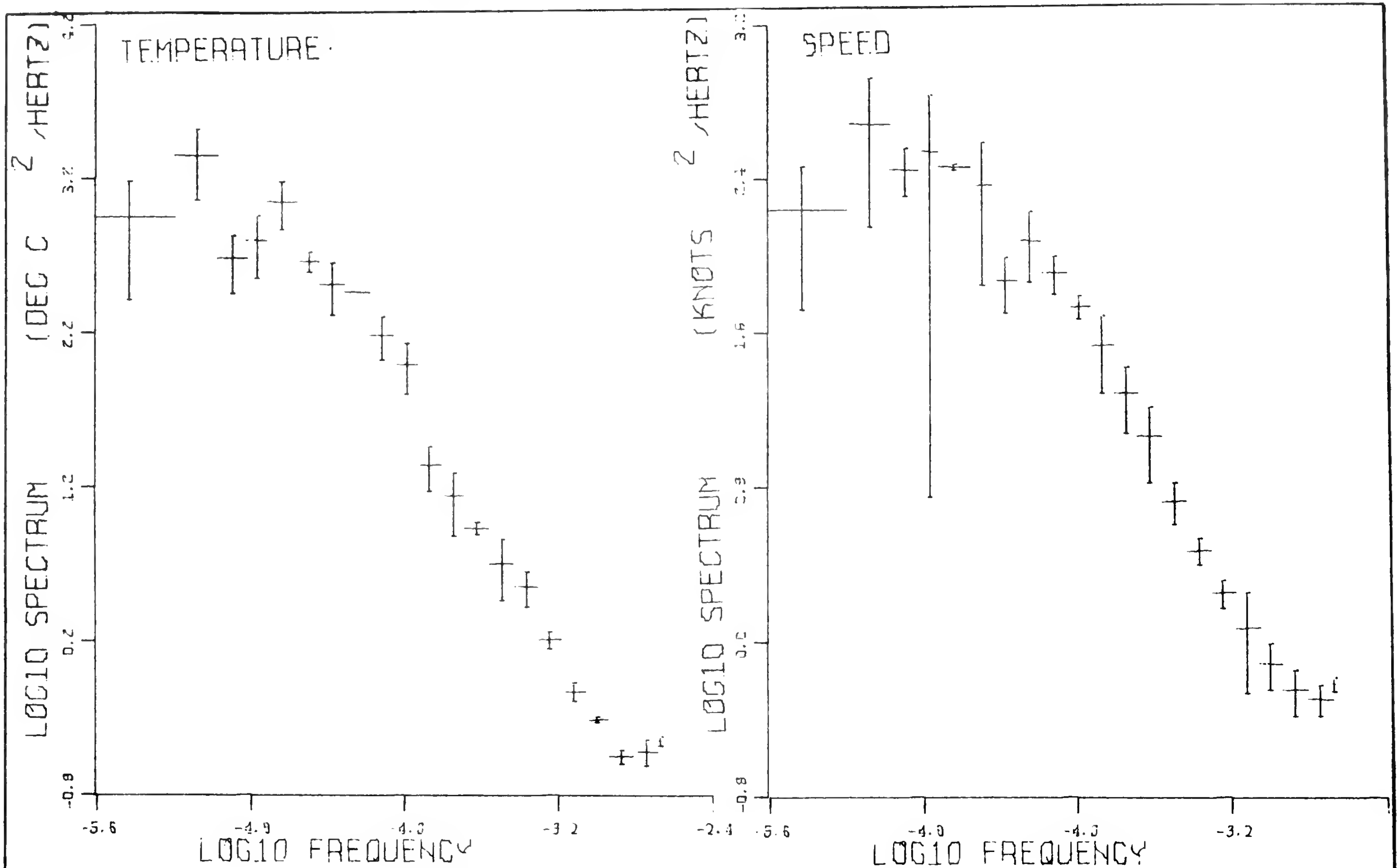


Figure 21. 1215 11 April to 1149 18 April 1969

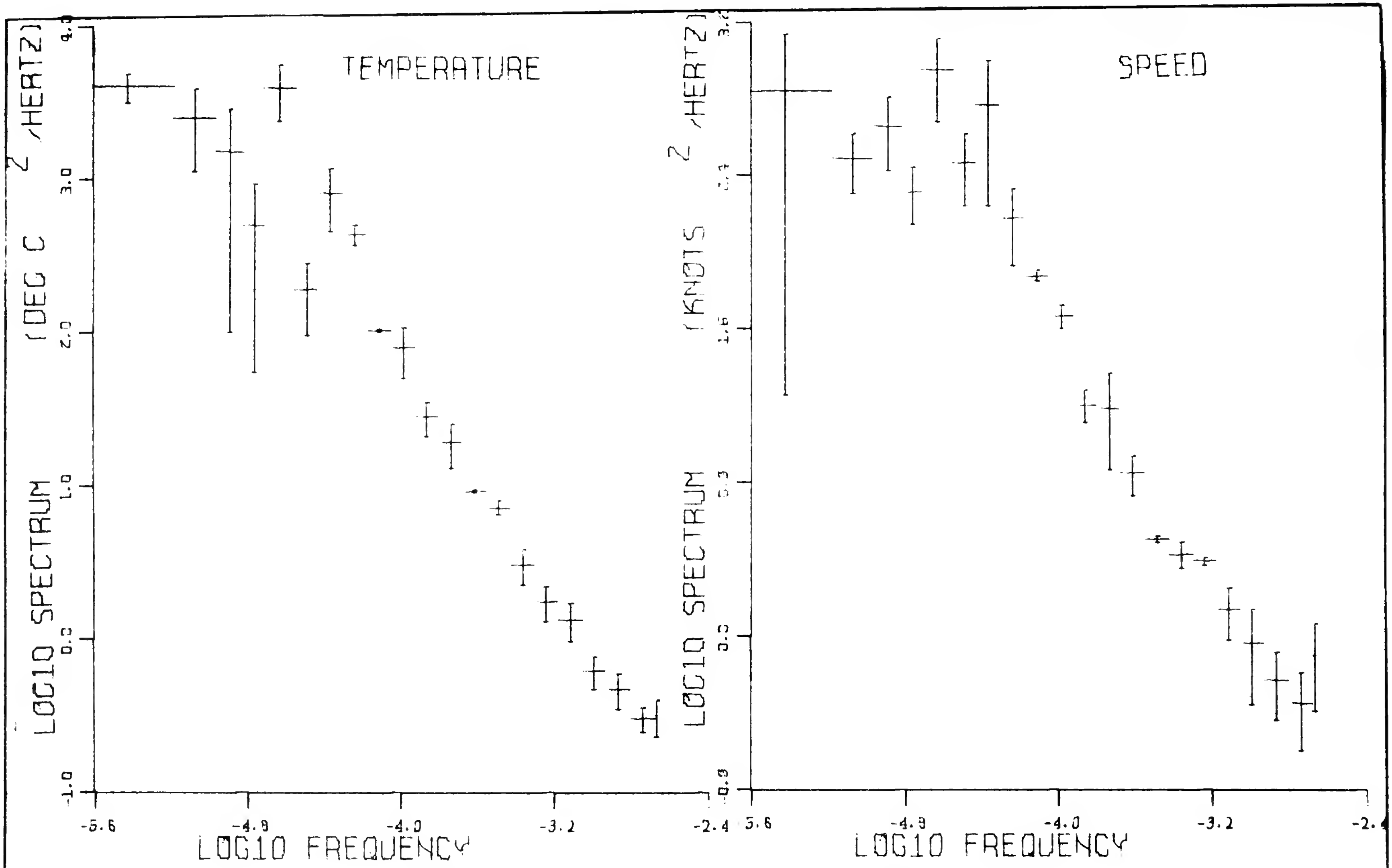
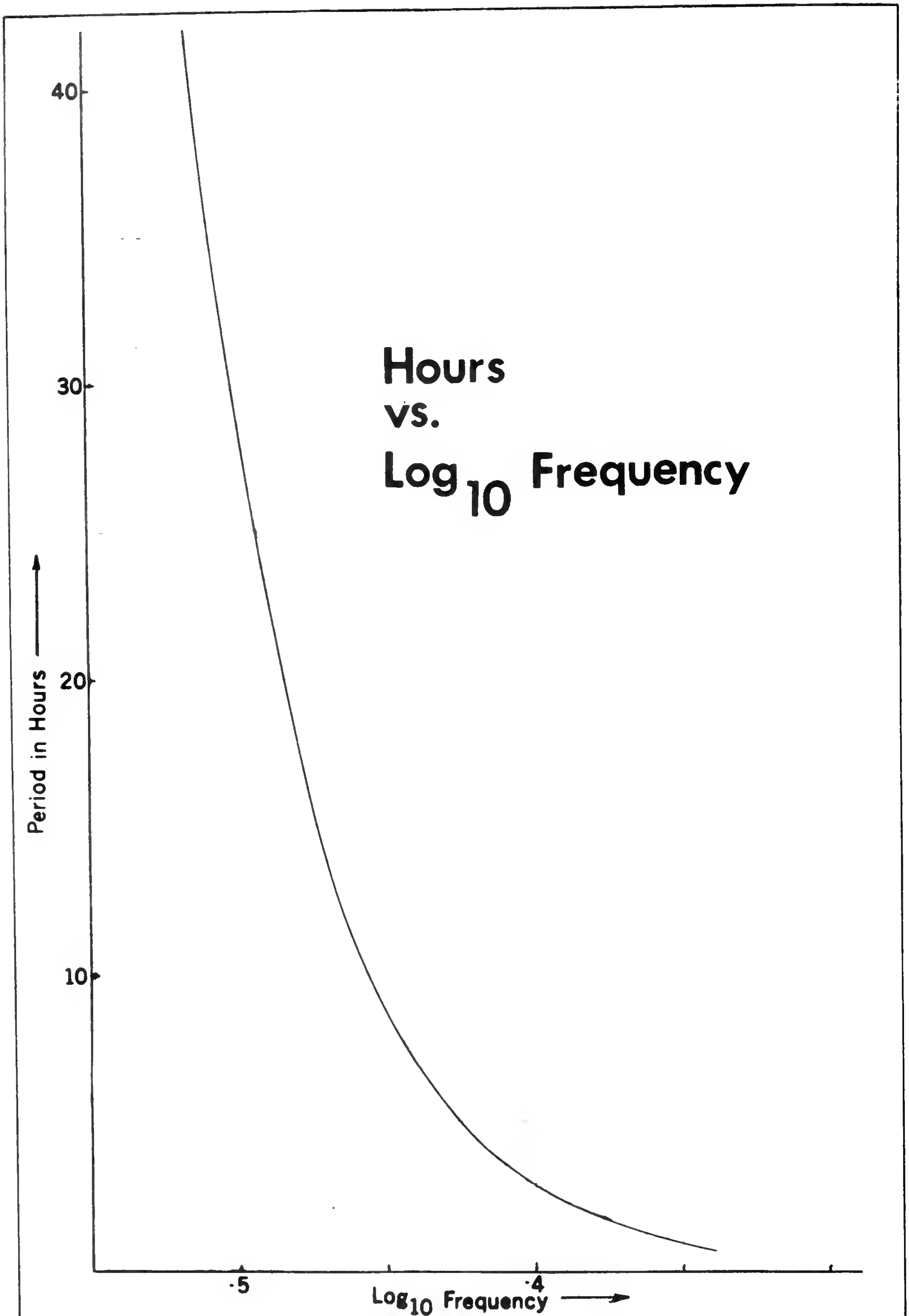


Figure 22. 0148 27 April to 0033 3 May 1969


Hours
vs.
Log 10 Frequency
Period in Hours
40
30
20
10
·5
·4
Log10 Frequency
Figure 23.

Dooley's and Njus' records are shown in Appendix E (Figures 52 to 58). Table IV combines these records and those collected during this investigation. For the longer records, periods of 22.75, 22.5, 12 and 11 hours are probably tidal periods. Periods of 35, 34.5, 31.5 and 31 hours are also noted and the driving forces for these periods are as of yet unknown. Dooley [1968] used spectral program BMD02T and reported a peak at 12 hours for temperature and peaks at 12, 4-6 and 2-3 hours for speed. Njus [1968] used spectral program GHOST and reported temperature peaks at 12.5, 6 and 4 hours and speed peaks at 12.5, 6, 4 and 2.5 hours.

Shepard and Marshall [1969] reported that periods of four hours might be associated with internal waves. The inertial period for the latitude of Monterey Bay is approximately 20 hours; however, no peaks at this period were observed.

Using Monterey Harbor tide records, Ranines [1967] found peaks from 19 to 39 minutes, while Robinson [1969] using Monterey Harbor and Santa Cruz Harbor tide records found peaks of approximately 30 minutes.

After all the records were plotted, it was noticed that the slope of the higher frequency portions were decreasing in a similar manner. Measurements of the slope of the fall-off portion of the spectrum yields, for most cases, a slope of -1.732/1 (60^{o}). Table V summarizes the values for all records. Batchelor [1959] discusses the inertial-convective sub-range (ISR) for turbulent measurements. A slope of -5/3 (-1.66) has been observed for the fall-off of the ISR.

The slopes for the temperature spectrum are approximately the same for all records taken from the Canyon. The spread is from -1.54/1 to

-2.14/1. The record from the shelf has a slope of -1.33/1. For speed, the slopes are -1.54/1 to -2.25/1 for Canyon records and -1.07/1 for the shelf record. This may indicate a constant method of energy transfer for the Canyon records, but a different method of energy transfer for the shelf record.

TABLE IV

SUMMARY OF POWER SPECTRUM

Figure Number	Date (Start of Record)	Length of Record (Hours)	Periods (Hours)	
			Temperature	Speed
52	1000 22 March 1967	50	None	5.5,1.75
53	1110 24 November 1967	56	None	4.5
54	1426 15 January 1968	154	20.5, 11	31, 11, 4.5, 0.5
55	0945 29 February 1968	56	4.5	5.5,0.75
56	1520 14 May 1968	81	9.75, 6, 2.25	9.75,4.5
57	1230 26 September 1968	159	11, 3.5	22.5, 12, 7
58	1050 17 October 1968	167	22.5, 12	12, 7, 4
20	1148 11 April 1969	171	34.5, 12, 5	16, 5, 0.5
21	1215 11 April 1969	168	31.5, 12	35, 16, 5
22	0148 27 April 1969	142	12, 7	22.75, 11, 7

TABLE V

SUMMARY OF SLOPE OF SPECTRUM DATA

Date (Start of Record)	Slope	
	Temperature	Speed
1000 22 March 1967	-1.54/1	-1.60/1
1110 24 November 1967	-1.66/1	-2.05/1
1426 15 January 1968	-1.73/1	-1.73/1
0945 27 February 1968	-1.73/1	-1.88/1
1520 14 May 1968	-1.88/1	-2.25/1
1230 26 September 1968	-1.80/1	-1.88/1
1050 17 October 1968	-2.14/1	-1.96/1
1148 11 April 1969	-1.33/1	-1.07/1
1215 11 April 1969	-1.73/1	-1.73/1
0148 27 April 1969	-1.60/1	-1.54/1

VII. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

Currents in the Monterey Submarine Canyon reach speeds of 51.5 cm/sec (the instrument's cut-off) and obviously go higher. Normally the speeds build up rapidly on a rising tide and decrease slowly on the falling tide. Motion is warm, down-canyon flow on rising tide and cold, up-canyon flow on the falling tide. Superimposed on the tidal up- and down-canyon flow is a flow probably due to longshore current across the Canyon. Scatter diagrams and progressive vector diagrams show this effect, indicating a net current set across the Canyon.

Currents on the shelf show lower speeds, seldom reaching 25 cm/sec. Data from the array north of the Canyon indicate flow into the Canyon in a southeastern direction. This is believed to be due to a predominate southerly longshore current caused by strong west to northwest winds during the observational period and the bottom topography of the Canyon which funnels the flow into and across the Canyon.

An attempt was made to correlate the direction of set and volume transport with Monterey Bay seasonal water conditions. However, only nine sets of data were used and they were of differing length, depth and location. Nevertheless, there is some indication of a relationship between currents in the Canyon and ocean season.

Power spectra of all data available show peak periods that correspond to the tide; however, other periods exist and their cause is not defined as of yet. The power spectrum program used computed a raw spectrum; since the tidal influence is very strong, other frequencies may be blanked out by the tide.

Measurement of the slope of the power spectrum revealed that this slope is nearly constant at -1.73/1. This suggests a uniform transfer of energy from low frequency to high frequency.

B. RECOMMENDATIONS

Further study of bottom currents is warranted. Continuous measurements at several locations in the Monterey Submarine Canyon, on the shelf area and at different depths would be desirable in order to better define the flow characteristics in the Bay. A simultaneous bathymetric and bottom composition study, combined with a study of the water's physical parameters by either STD or Nansen casts at the location of current measurements,would more completely define the oceanographic conditions.

Ten records each longer than 50 hours are now available for further analysis. Dooley [1968] and Njus [1968] have suggested re-evaluation of their data by filtering out the tidal components. While more data is needed, the available data should be reanalyzed in accordance with their suggestions.

Two limitations now inhibit study of the near-bottom currents. First, the amount of line necessary for the taut-line moor in deeper sites is reaching proportions that cannot be handled on the Naval Postgraduate School research boat. The system should either be redesigned to accommodate the boat or research should be done from a larger vessel.

Secondly, data reduction is a time-consuming task and limits the amount of information one can collect and effectively handle. The digitizer at the Fleet Numerical Weather Facility Pt. Pinos Annex offers a solution to this problem. Not only would data reduction be faster using this device but the sampling interval would be smaller, allowing the investigator to look at higher frequencies.

APPENDIX A

DIFFICULTIES WITH TAUT LINE MOORING

On 19 February 1969, three current meters were placed in the following locations:

Position		Depth
36° 48.8'N	121° 51.9'W	91 meters
36° 47.9'N	121° 51.7'W	366 meters
36° 46.9'N	121° 51.6'W	91 meters

These positions are approximately 5.5 km west of Moss Landing. The R/V OCEANEER was used for launching. The southern-most array used a subsurface float and release mechanism that had not been used at sea. All surface floats were made of styrafoam, colored international orange, and banded together between sheets of plywood with a short wooden staff with a red flag attached to it.

The OCEANEER was to recover the meters on the 25th of February. During the period the meters were in the water, extremely high winds were experienced in the Bay. On the day of recovery, the center and northern meters were found (one without a surface float) and the southern meter and its surface float were not found.

On the 26th of February, both of the remaining releases failed upon cocking due to breakage of the cocking pawl, so attempts to reset the meters were aborted. Of the two meters recovered, one had malfunctioned in the chart recorder and the other had little usable data because it did not have the 102 by 61 cm vane attached and it had been set for high scale speed of zero to 360.4 cm/sec. A decision was then made to install vanes on the two meters and have the Naval Postgraduate School Machine Facility make new cocking pawls.

On the 27th, the USCGC CAPE WASH (95310) attempted to drag the area of the missing meter. Due to rough seas, high wind and the Cutter's high minimum speed, the drag was of questionable value. An Army helicopter from U.S. Army Base, Fort Ord was used the next day to search the beach area from Fort Ord to Santa Cruz and back. Neither the meter nor the two missing floats were seen. Winds had been onshore and it was felt that if the equipment had been missed at sea it would have drifted ashore.

As soon as the meter vanes were installed, the cocking pawls built and the Naval Postgraduate School's sixty-three footer available, the meters were reset with the assistance of Lt. Dana W. Starkweather, USCG and Major James Neehan, USMC. This took place on 12 April with the meters being placed at the center and northern positions attempted previously. After setting the meters, a drag was made for the missing meter with no results.

The above two meters were recovered by the author and Mr. Jack Mellor on 18 April. Although plans were originally made to reset the meters immediately after they were recovered, sea conditions dictated that the meters be reset under more favorable circumstances. One styrafoam float was missing.

Two meters were to be reset by the author and Mr. Bob Middleburg on 25 April. One meter was placed at the center location and another was to be placed in 549 meters (300 fathoms) of water. As the meter was being lifted over the boat's lifelines, the instrument package cover snapped off and fell into the sea, so only the 366-meter position was occupied.

The meter was due to surface on 2 May; however, it was not found. On the 3rd of May an Army spotter plane searched the beach areas with no results. The meter was finally found on the 16th of May in approximately 274 meters of water (the length of line from the release to the subsurface float is approximately this distance).

The cocking nut on the release apparently had not turned completely when the release squib fired. It appeared that the edge of the nut had finally worn away and released the recoverable portion of the mooring, which drifted ashore until anchoring itself with the release mechanism. The styrafoam surface float was never found.

Lessons learned were:

(1) The aluminum vane is needed on the Model 501B current meter.
(2) Only the low speed scale should be used for bottom current measurements.
(3) After the current meter has been turned on, the instrument package cover should be wired closed.
(4) The surface float should have little freeboard to cut down the effects of wind, and if the releases are to be trusted the surface floats are of little use.
(5) If at all possible, pick a period of light winds to moor and recover the arrays.

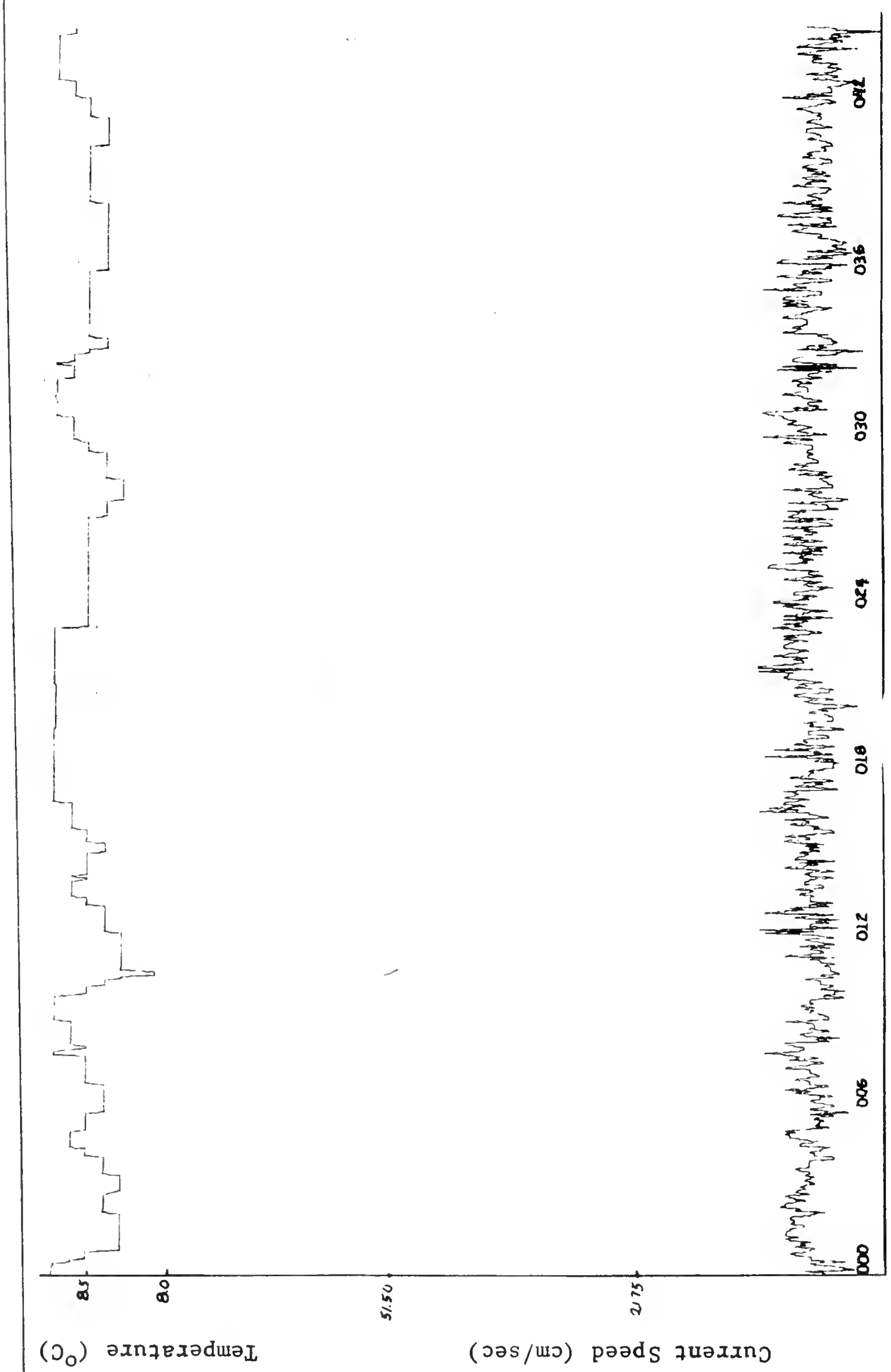


Figure 24a. 1148 11 April to 0848 13 April 1969

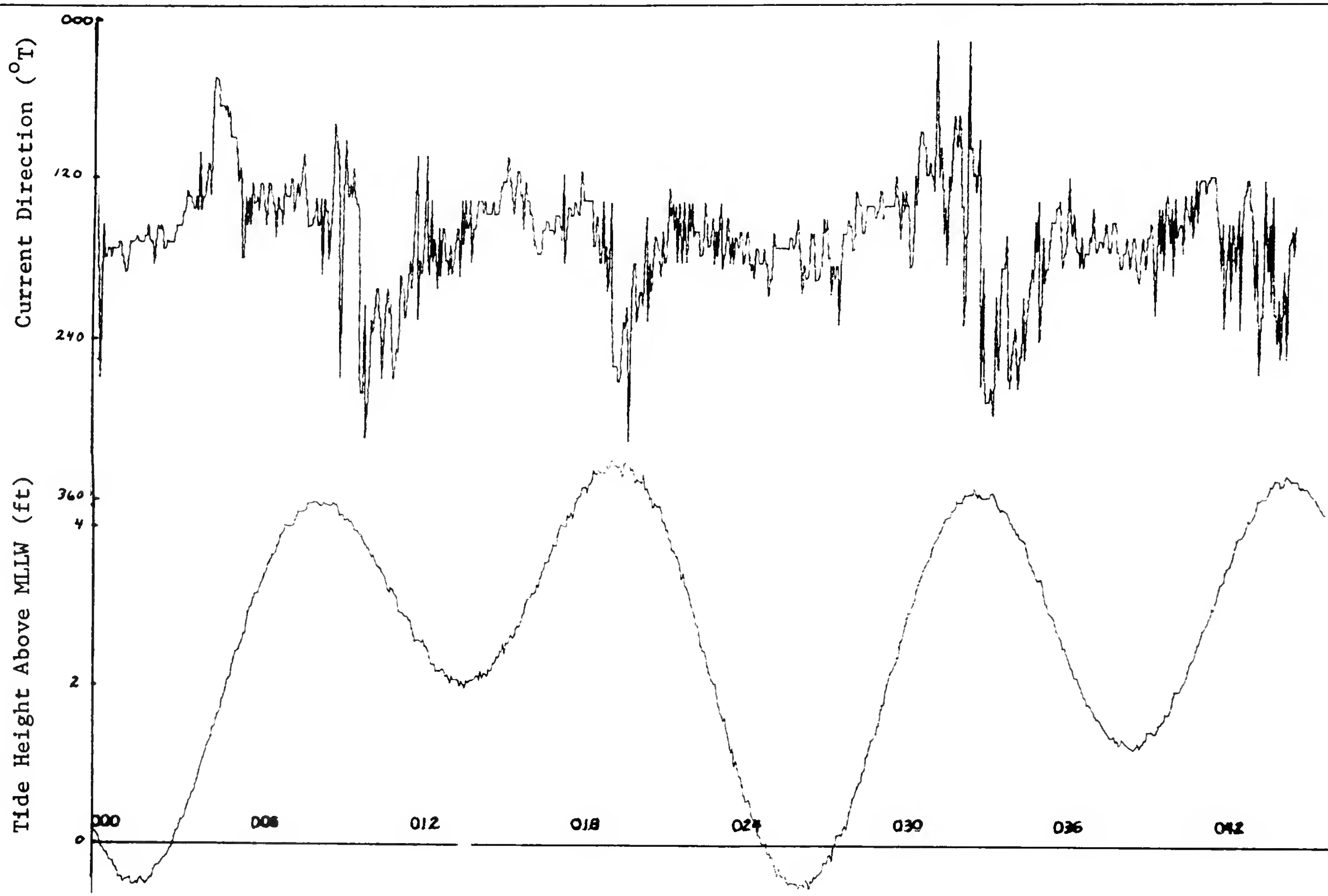


Figure 24b. 1148 11 April to 0848 13 April 1969

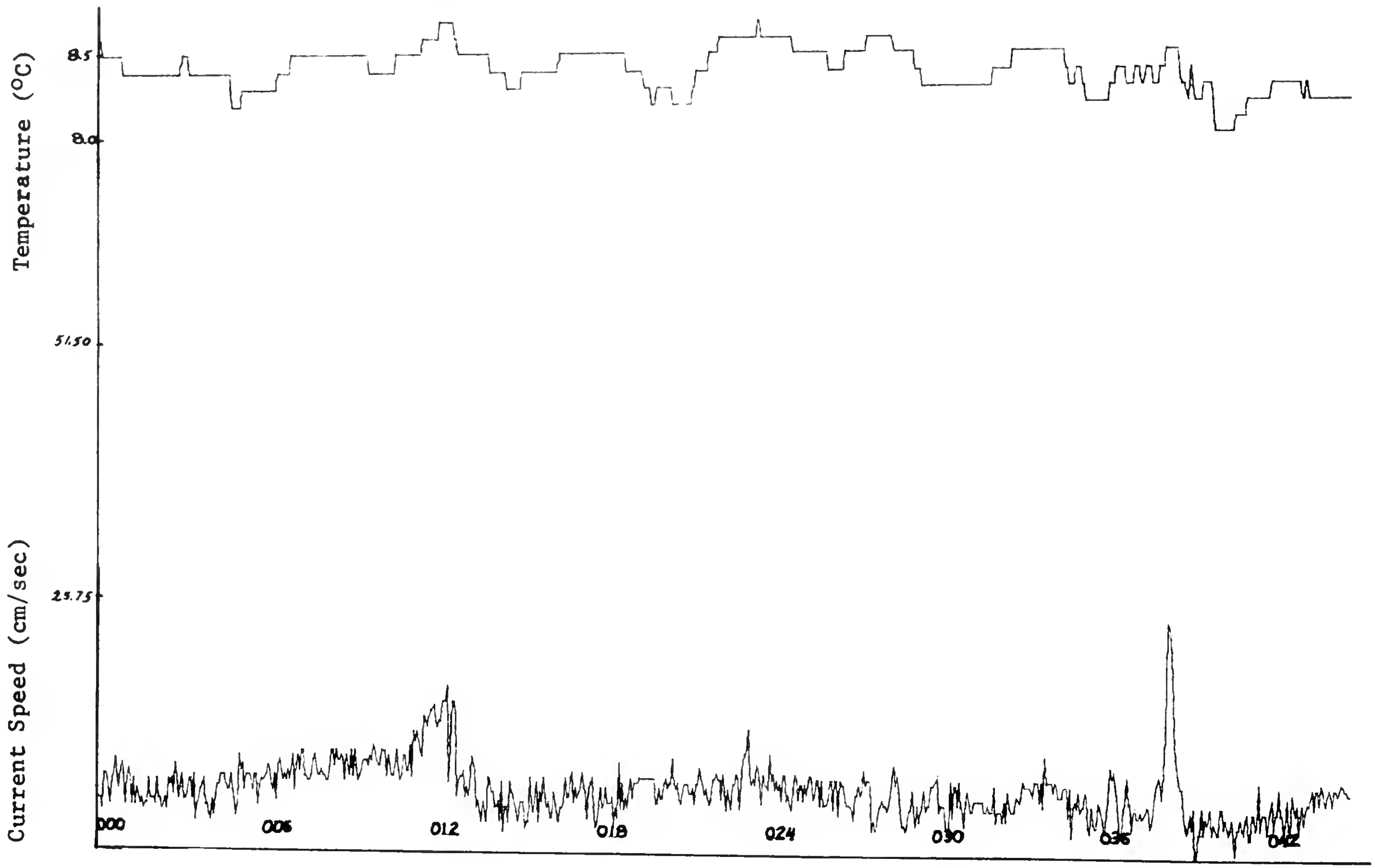


Figure 25a. 0848 13 April to 0548 15 April 1969

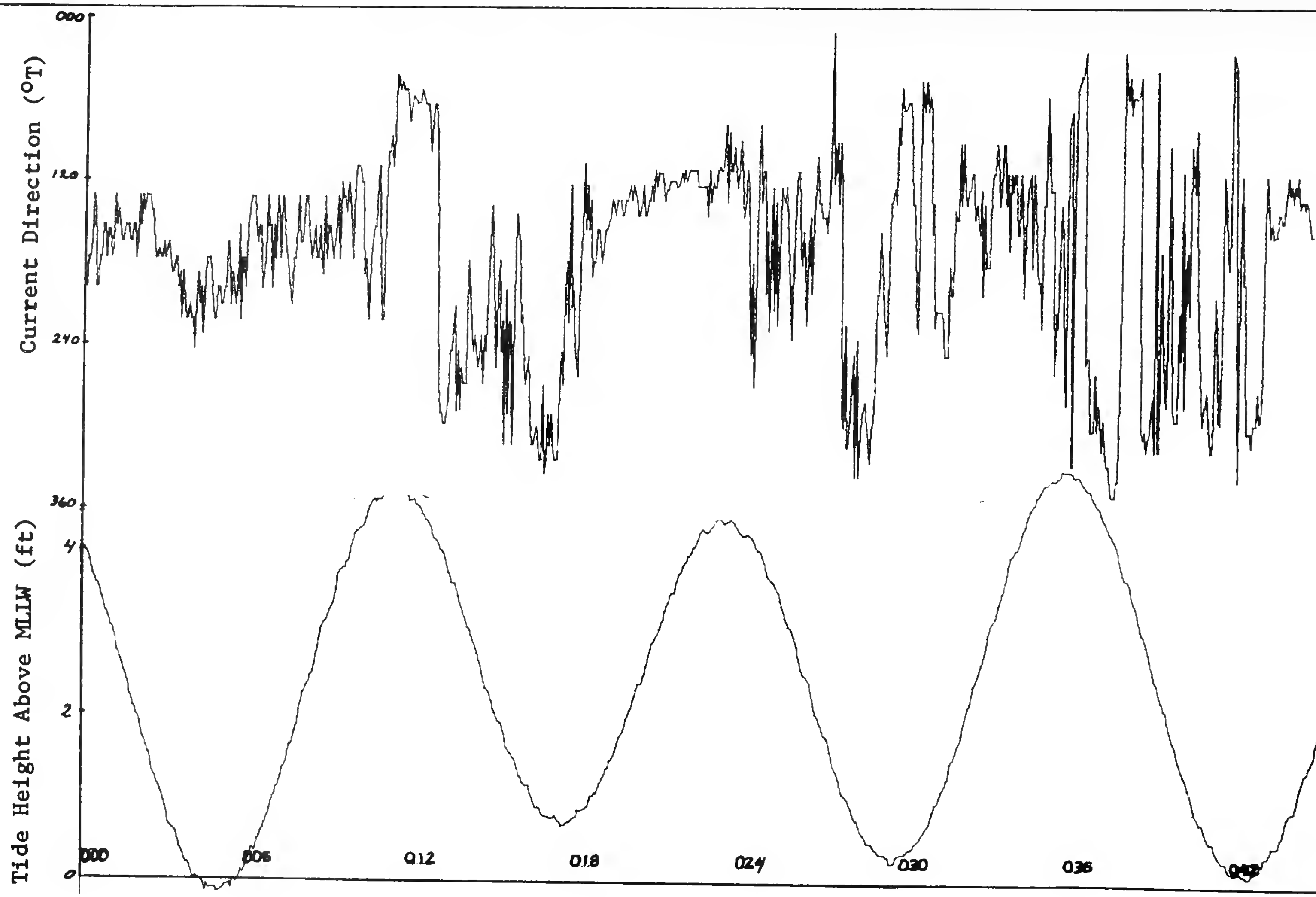


Figure 25b. 0848 13 April to 0548 15 April 1969

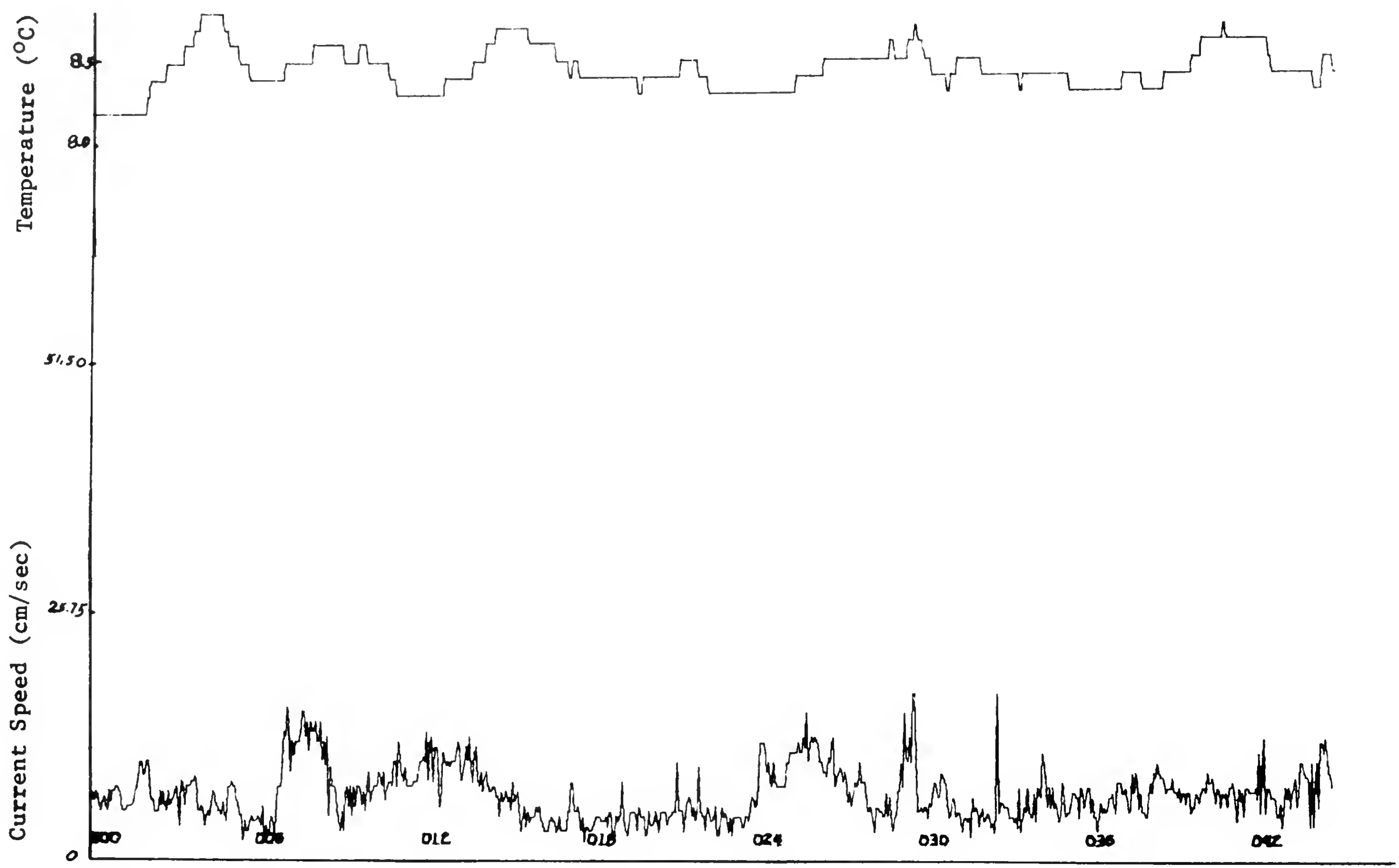


Figure 26a. 0548 15 April to 0248 17 April 1969

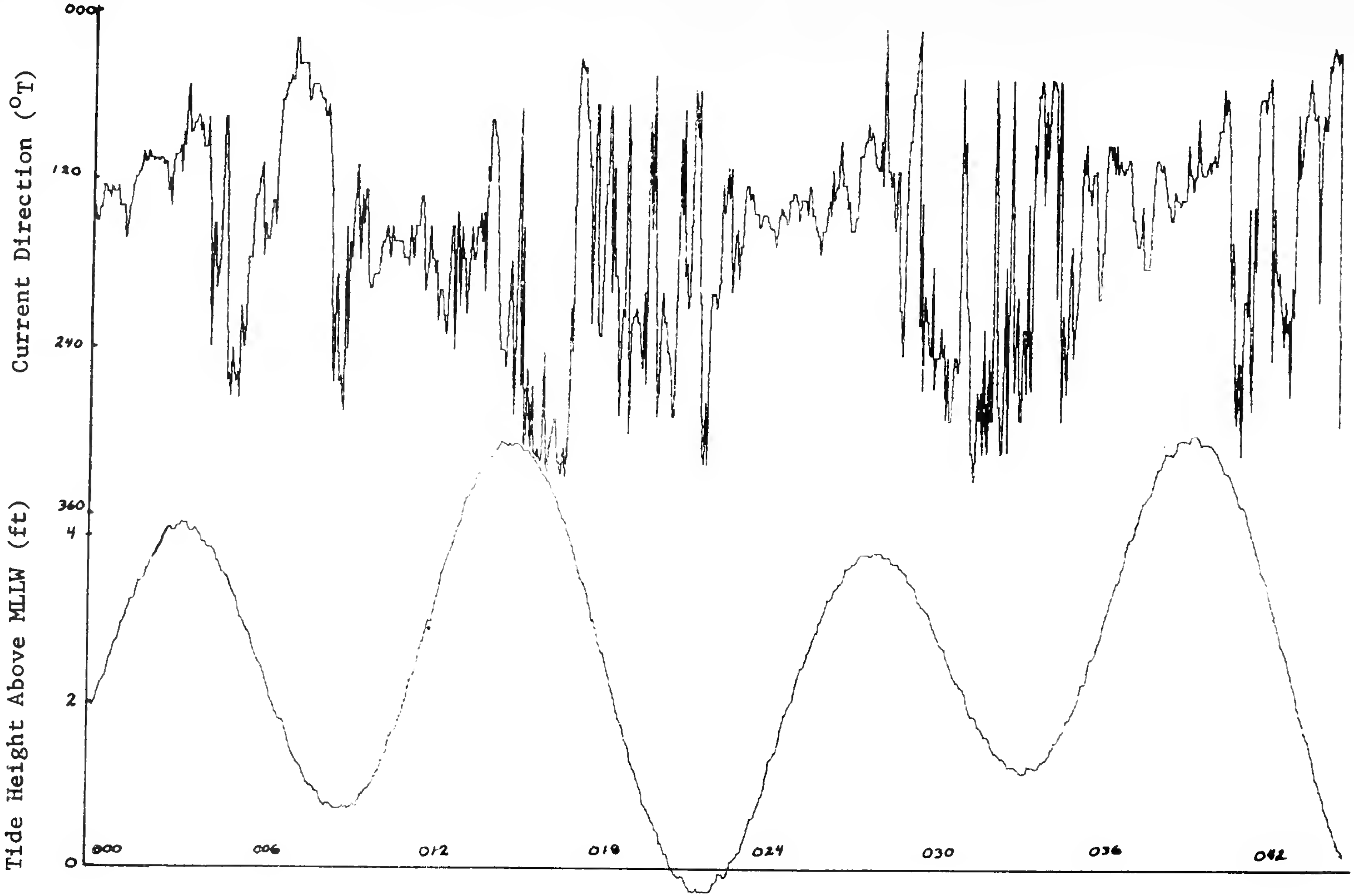


Figure 26b. 0548 15 April to 0248 17 April 1969

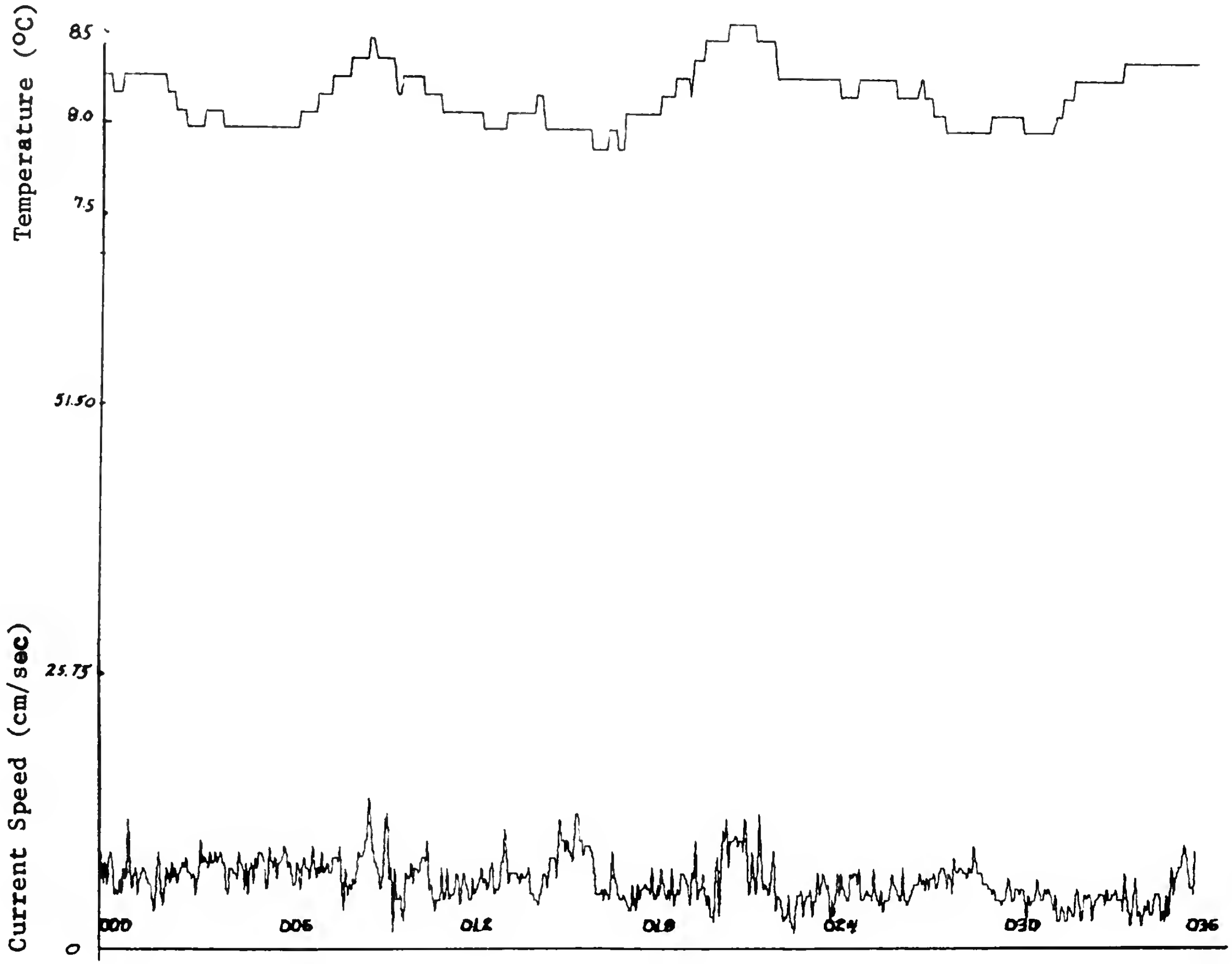


Figure 27a. 0248 17 April to 1503 18 April 1969

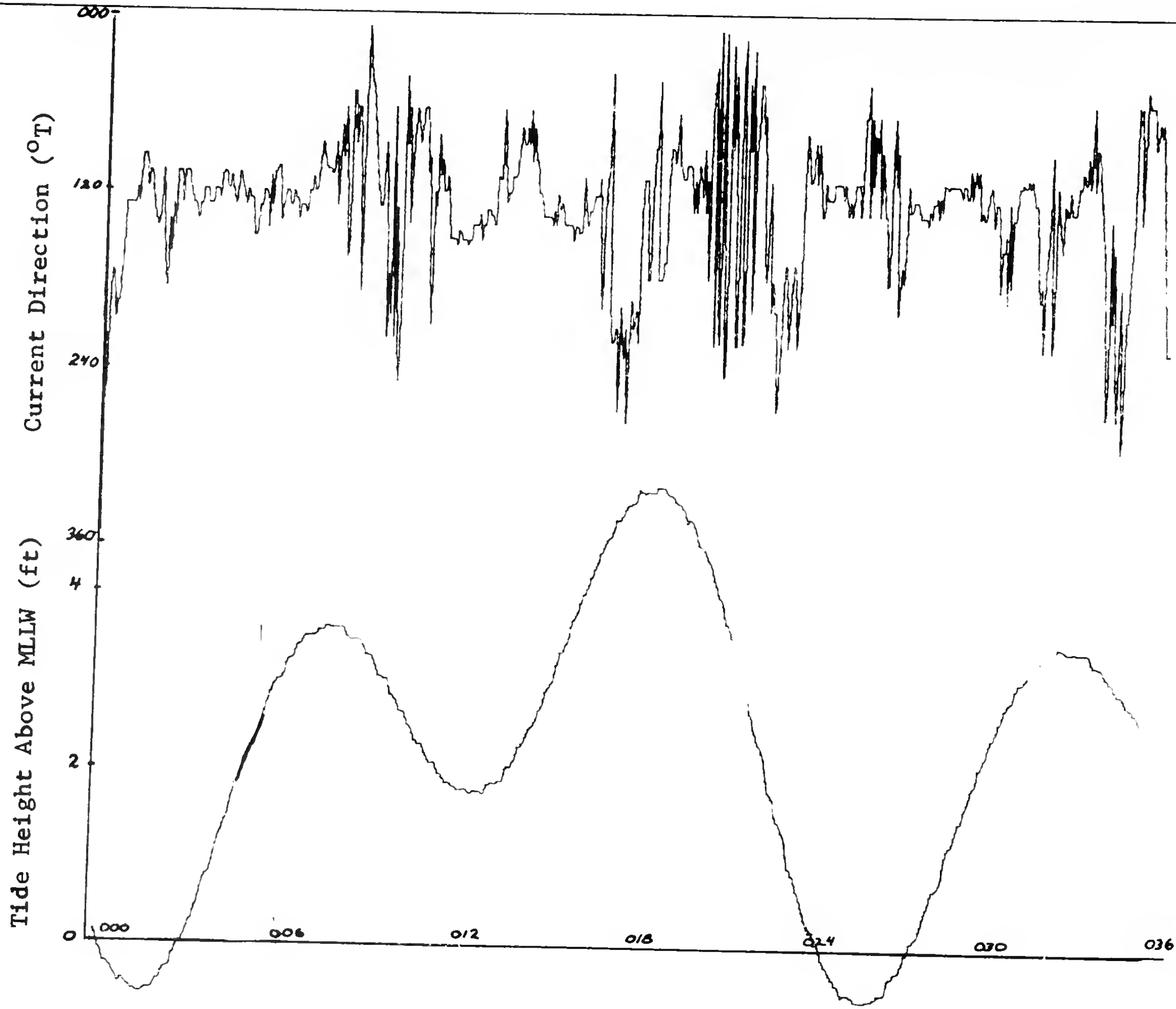


Figure 27b. 0248 17 April to 1503 18 April 1969

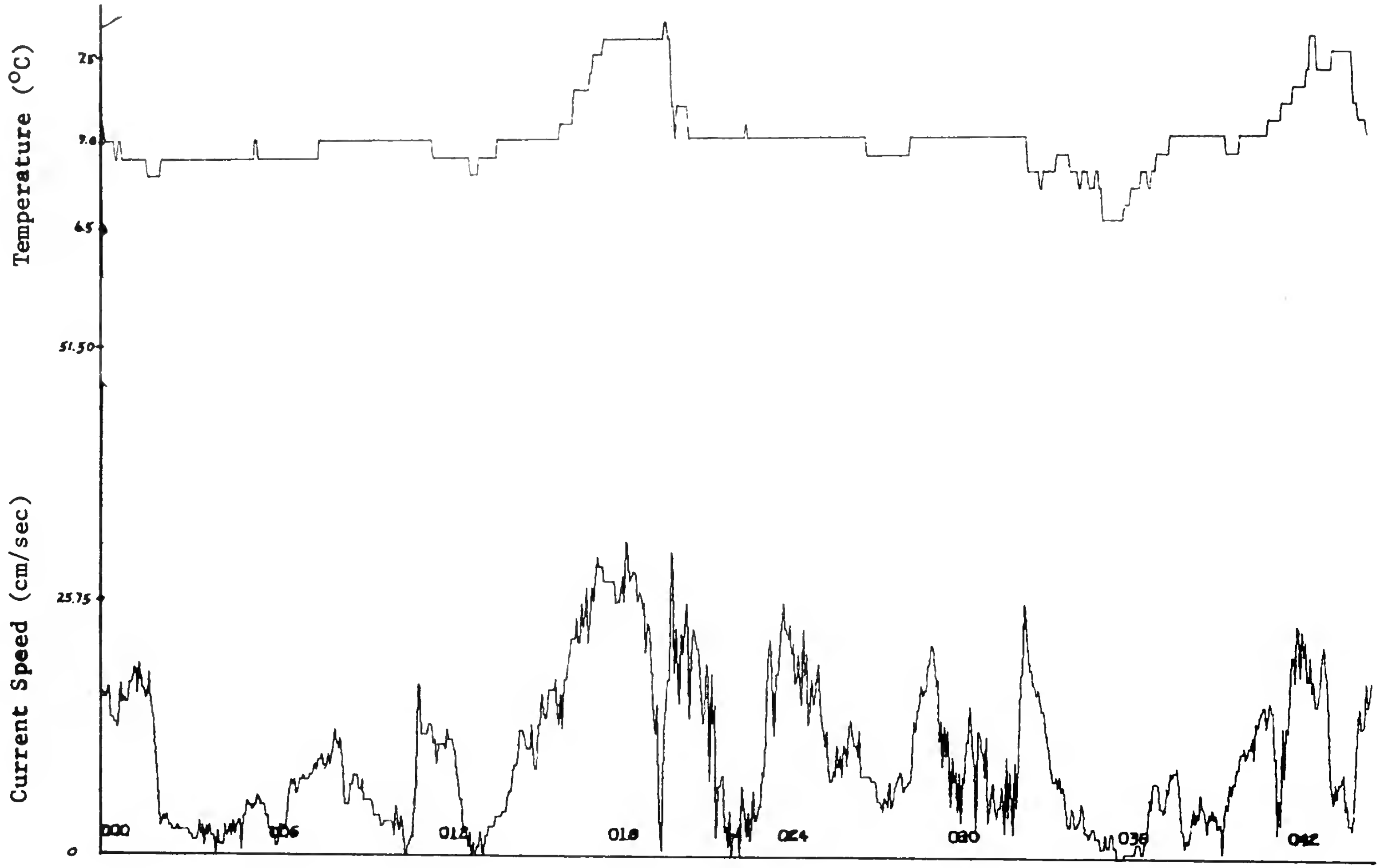


Figure 28a. 1215 11 April to 0915 13 April 1969

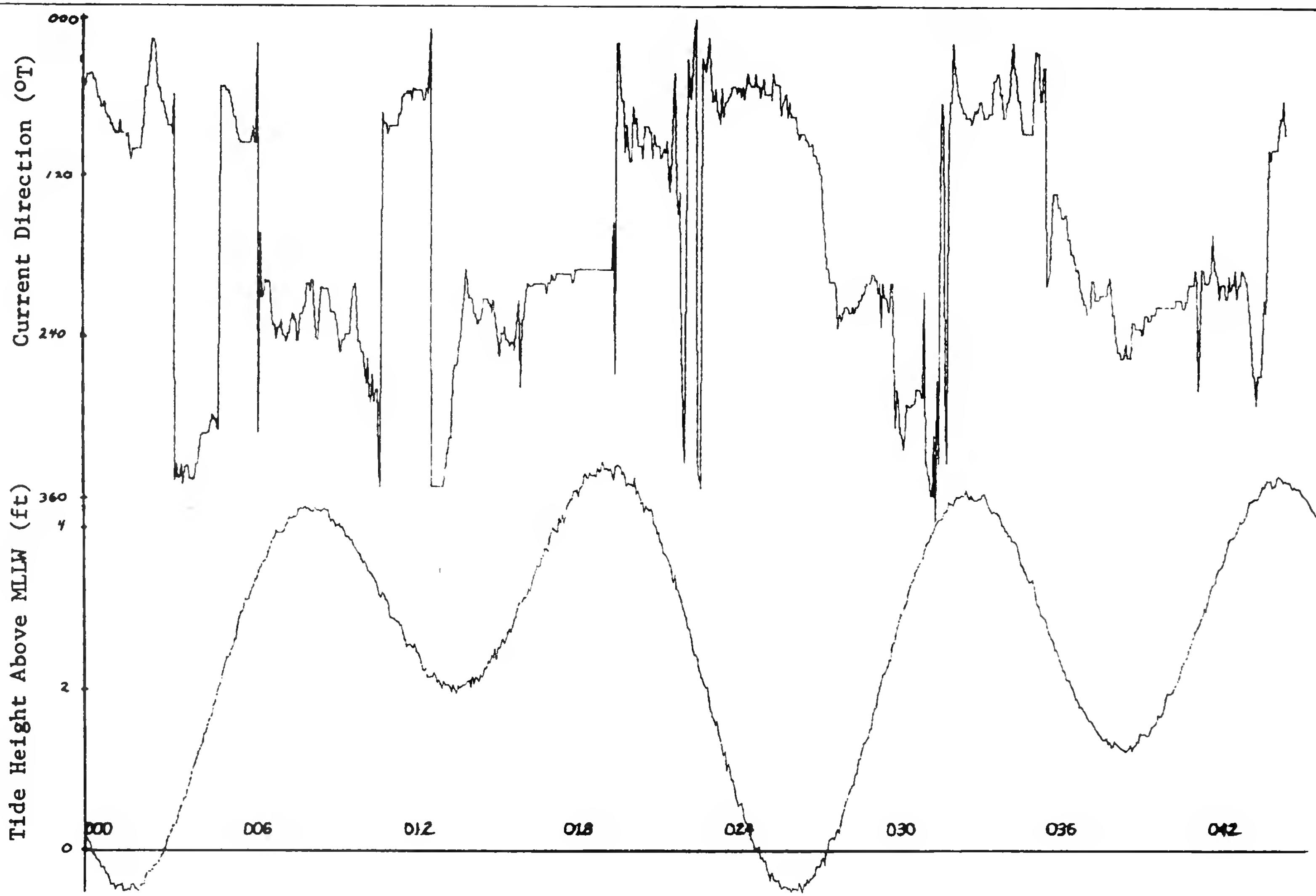


Figure 28b. 1215 11 April to 0915 13 April 1969

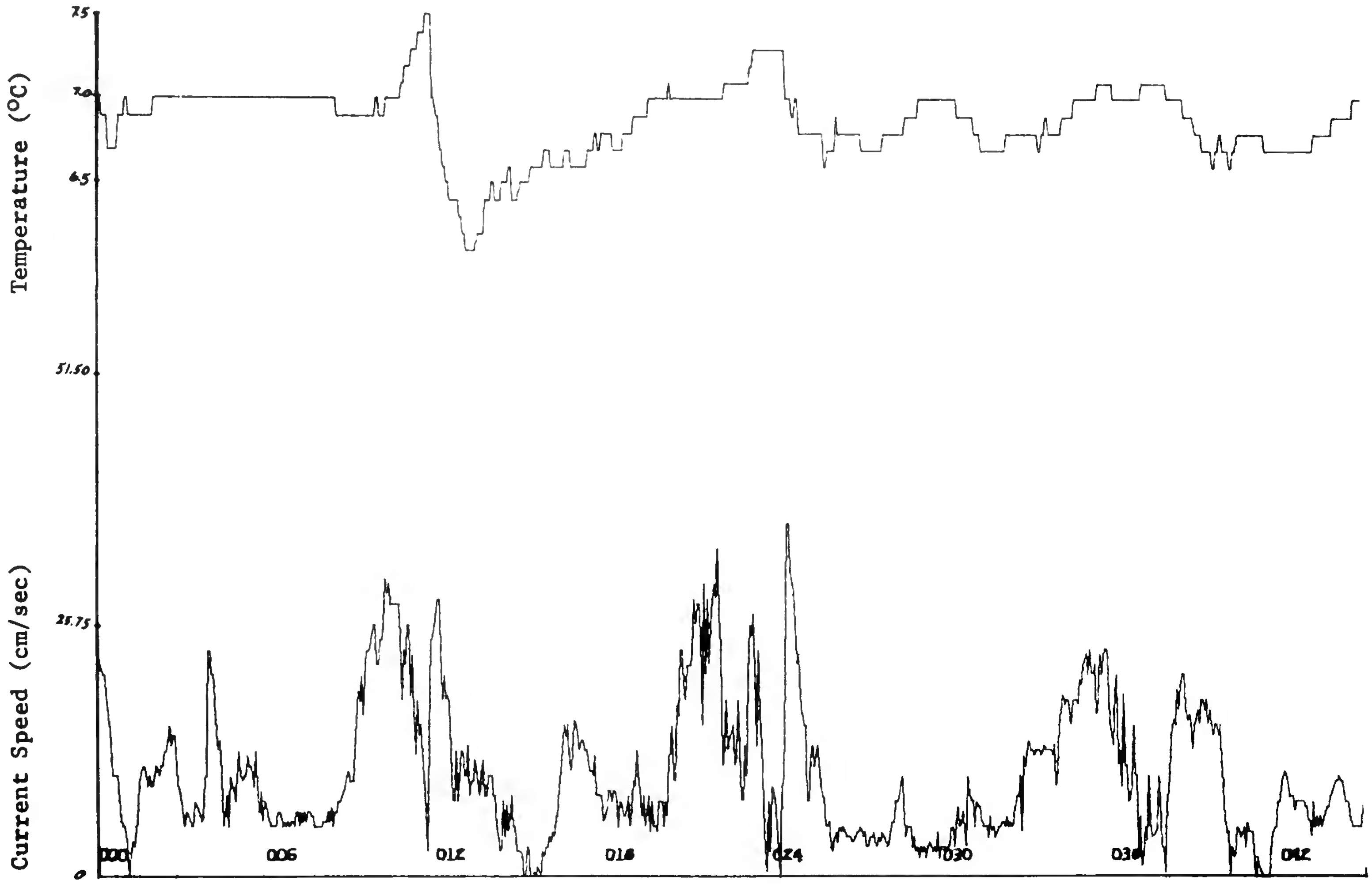


Figure 29a. 0915 13 April to 0615 15 April 1969

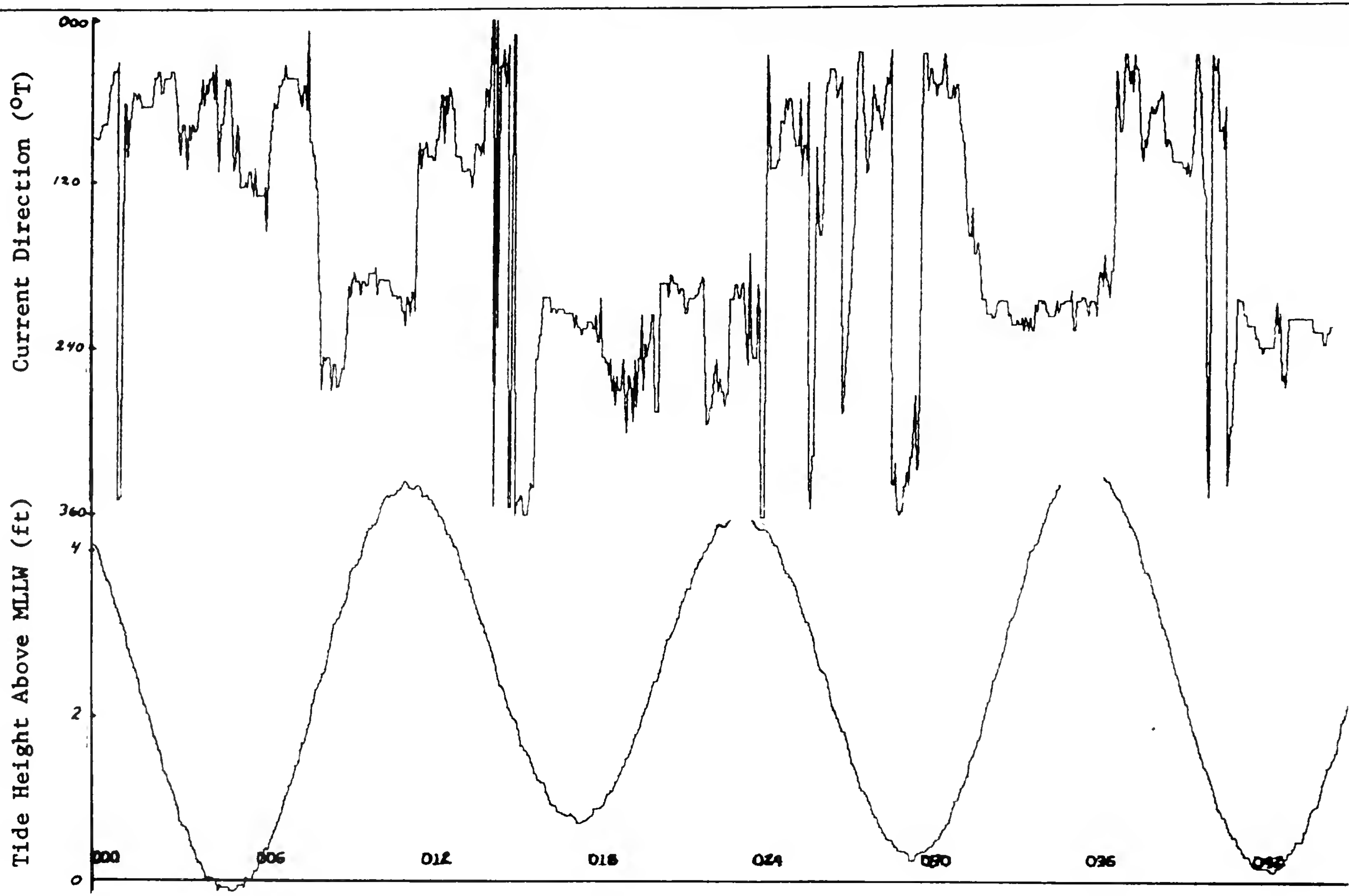


Figure 29b. 0915 13 April to 0615 15 April 1969

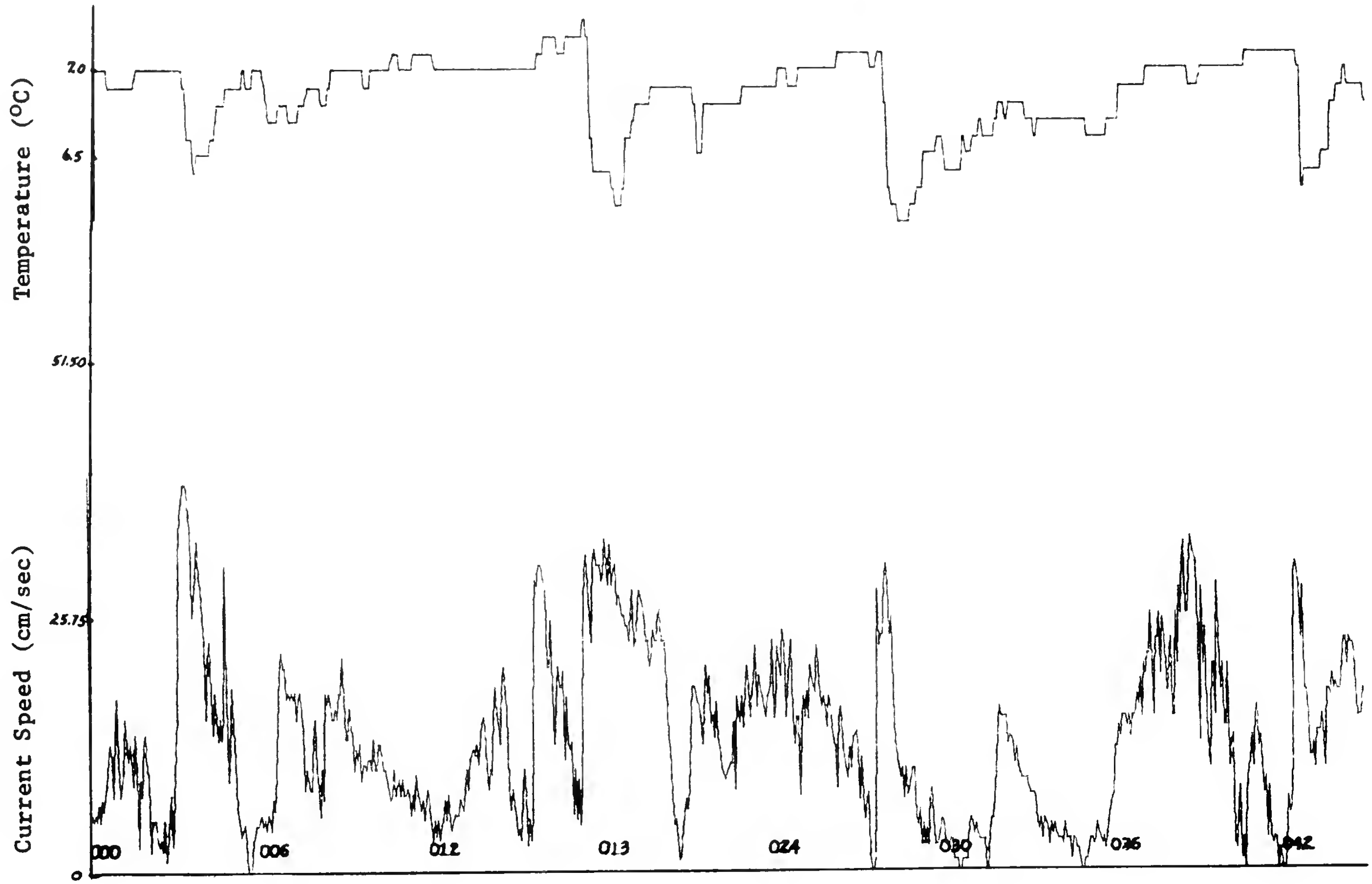


Figure 30a. 0615 15 April to 0315 17 April 1969

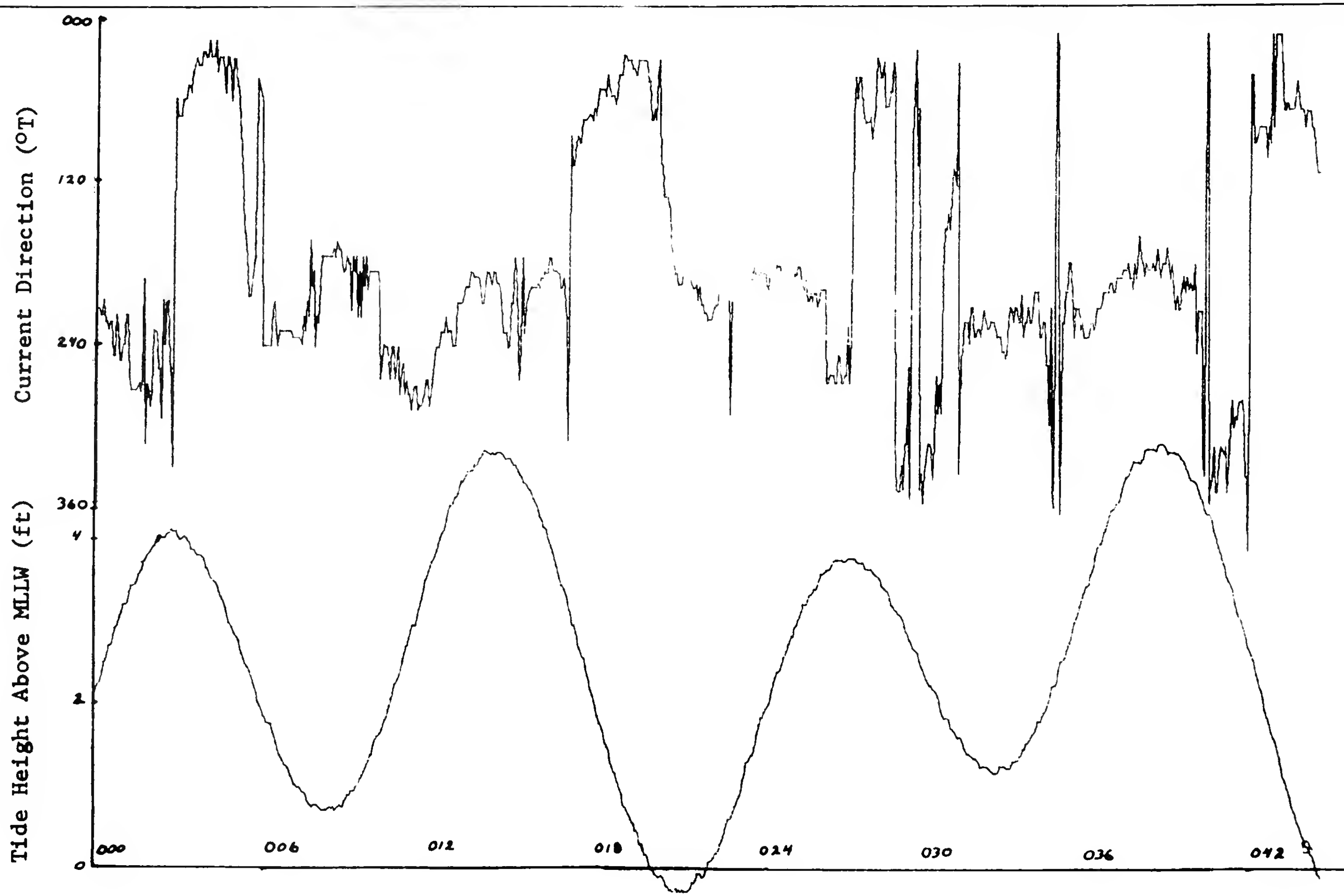


Figure 30b. 0615 15 April to 0315 17 April 1969

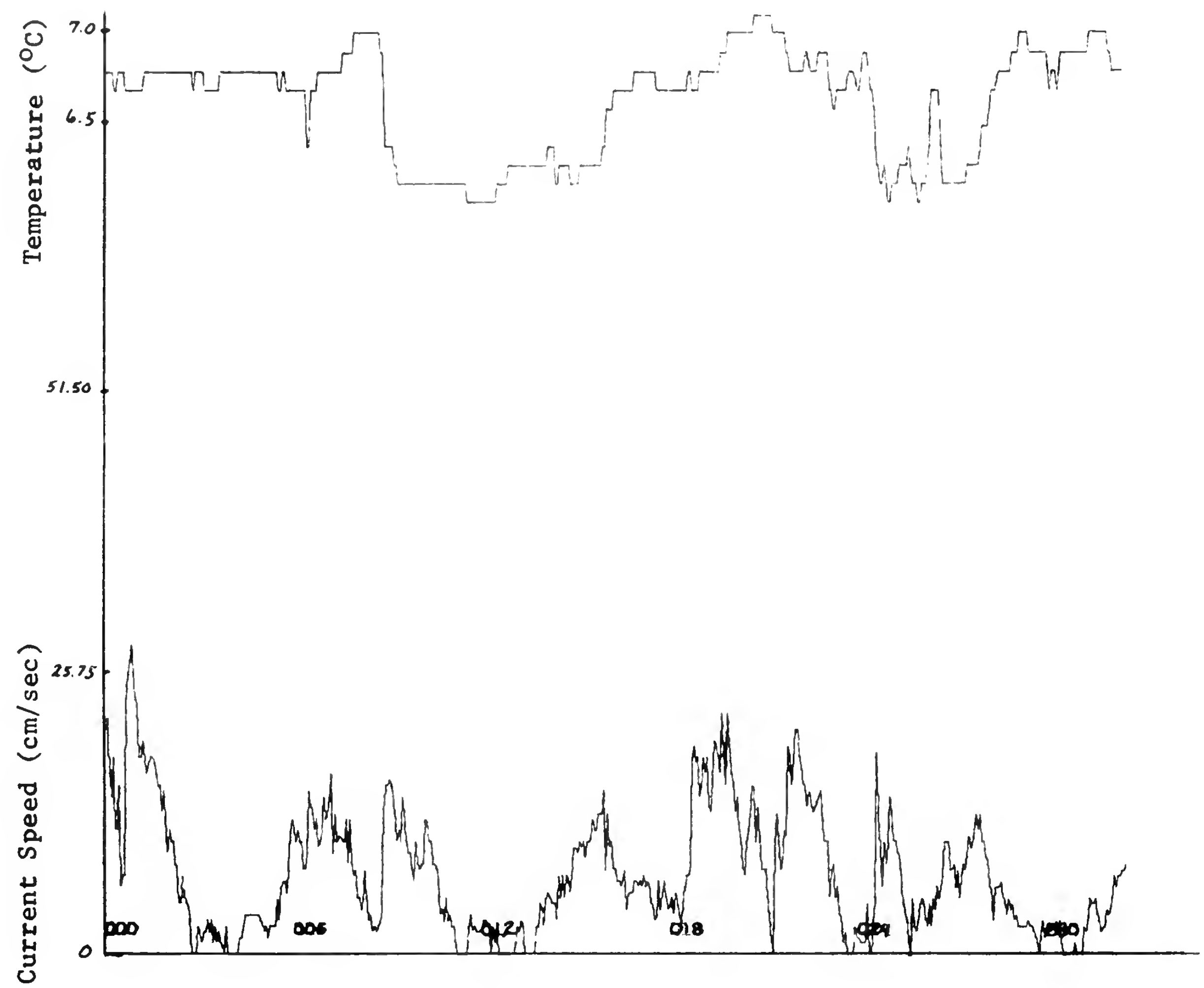


Figure 31a. 0315 17 April to 1149 18 April 1969

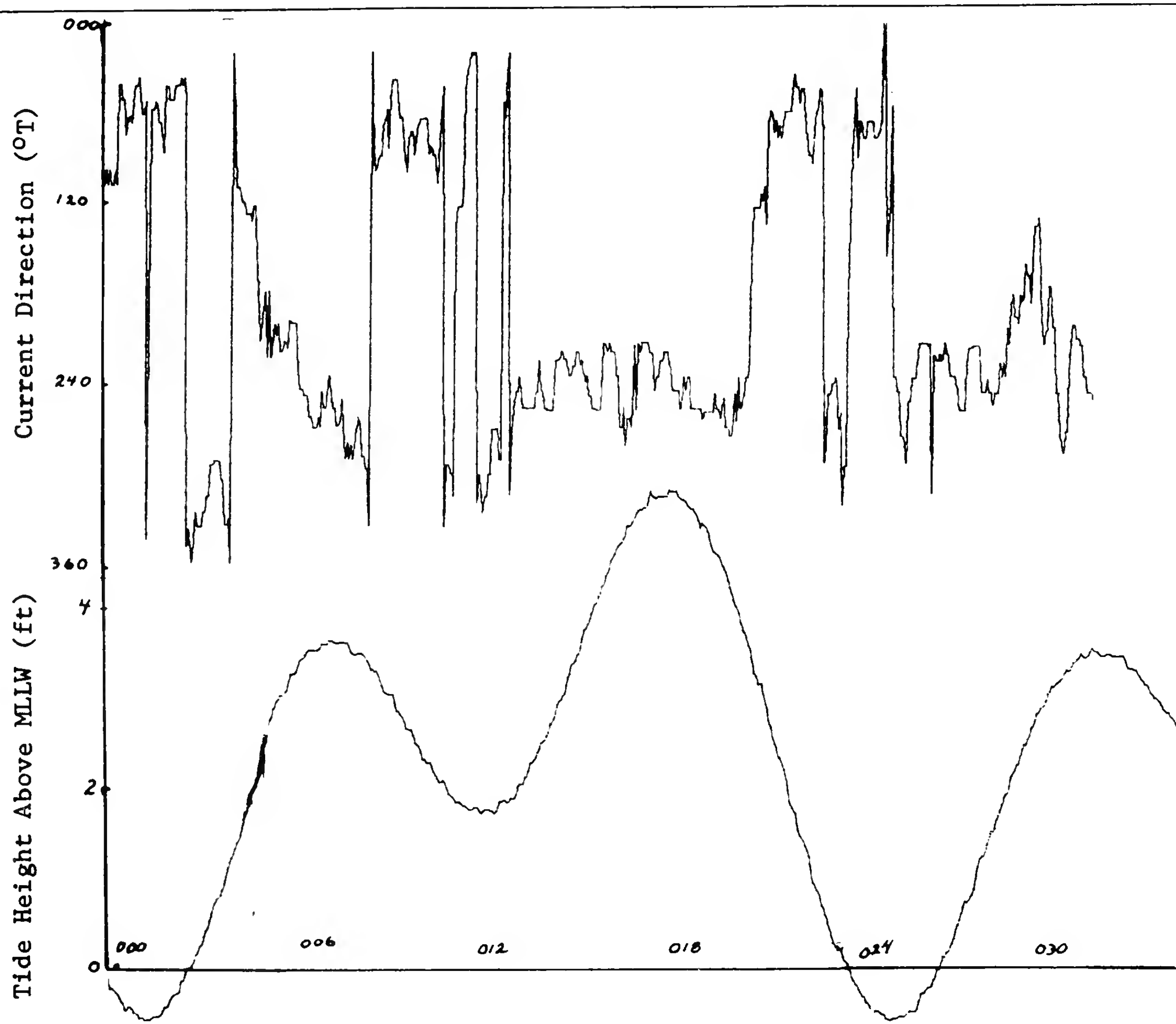


Figure 31b. 0315 17 April to 1149 18 April 1969

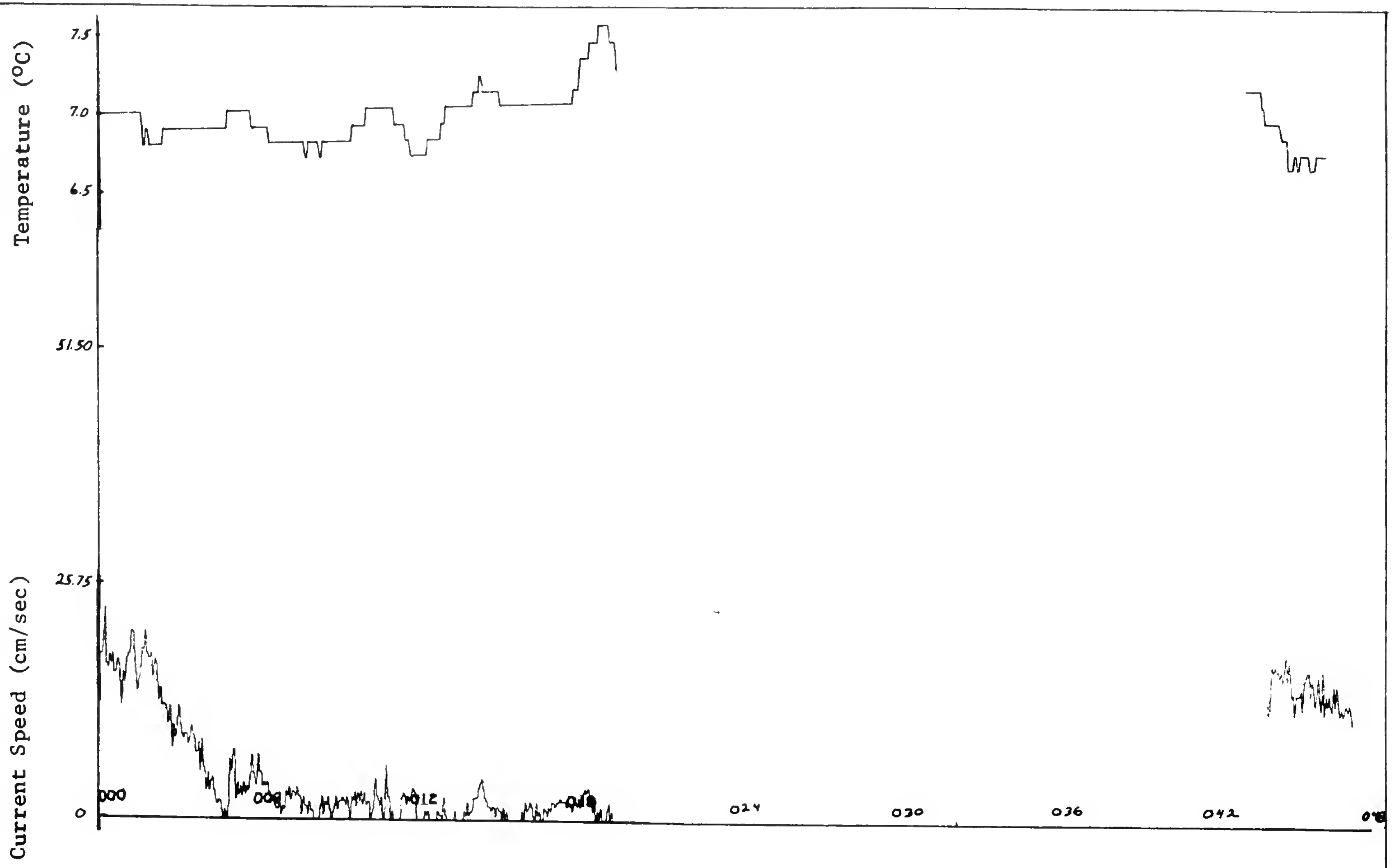


Figure 32a. 1118 25 April to 0714 26 April and 1038 26 April to 1357 26 April 1969

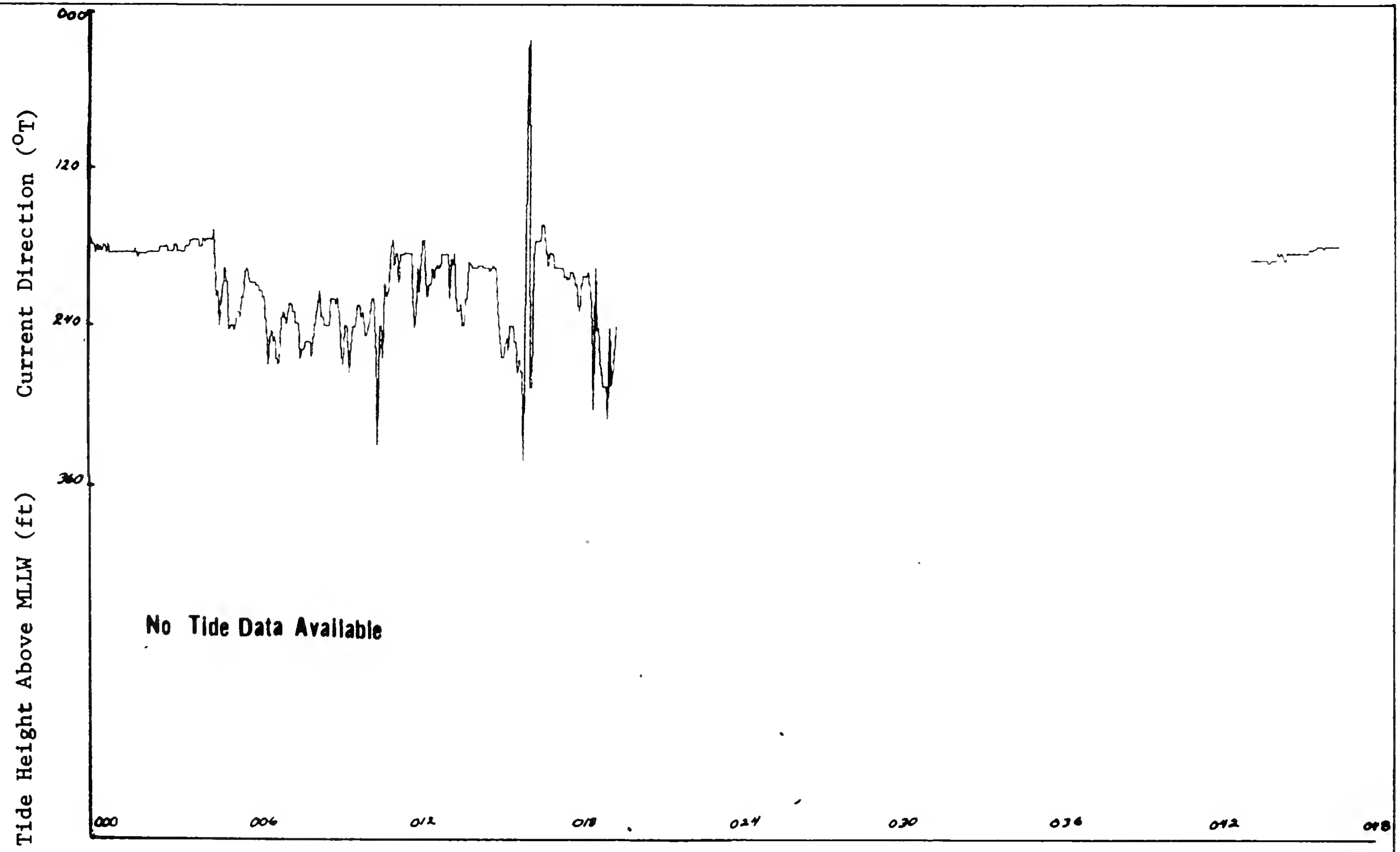


Figure 32b. 1118 25 April to 0714 26 April and 1038 26 April to 1357 26 April 1969

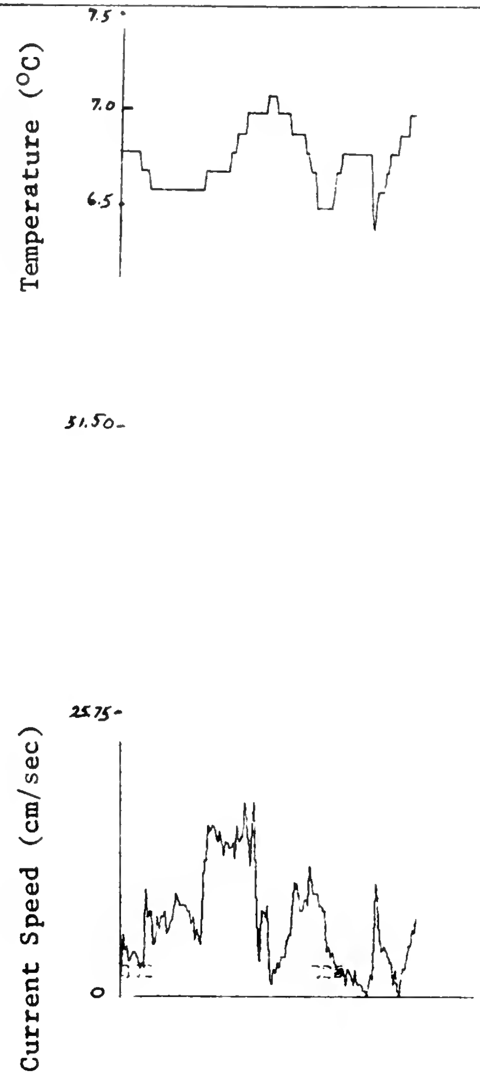


Figure 33a. 1533 26 April to 0052 27 April 1969

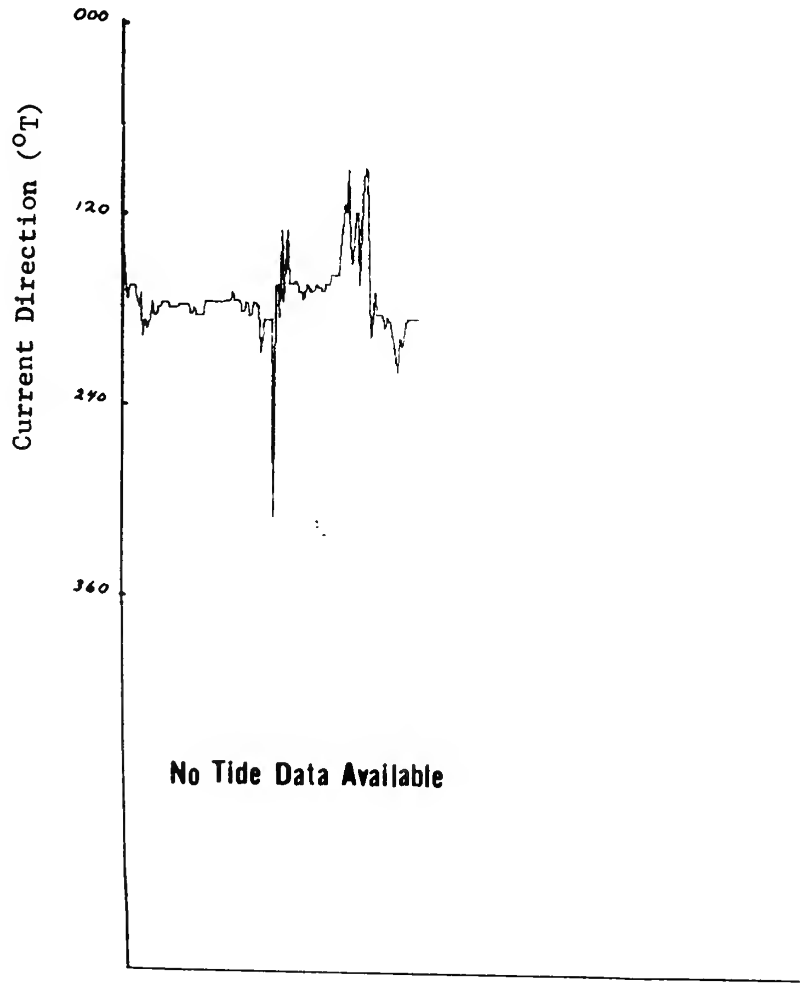


Figure 33b. 1533 26 April to 0052 27 April 1969

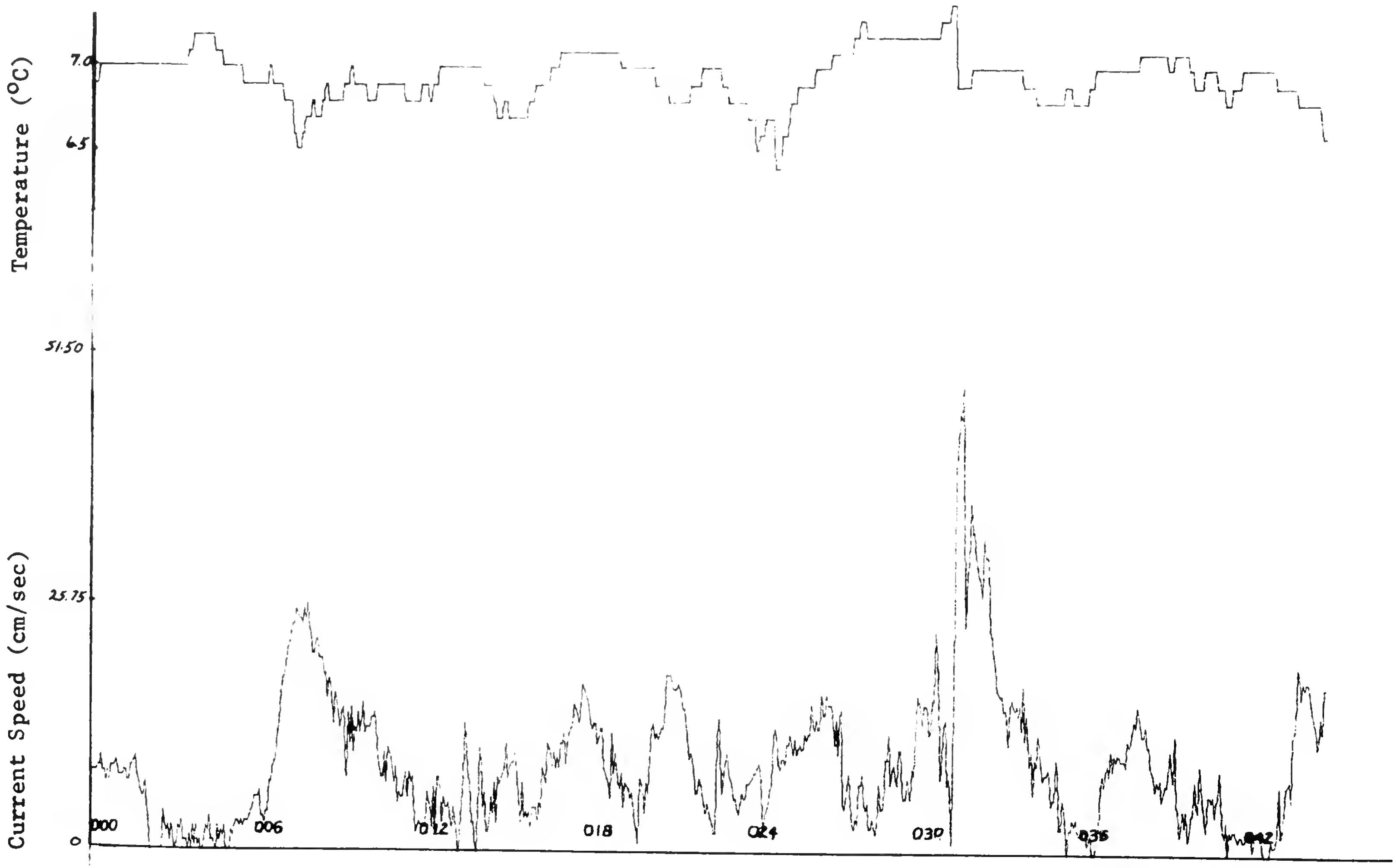


Figure 34a. 0148 27 April to 2248 28 April 1969

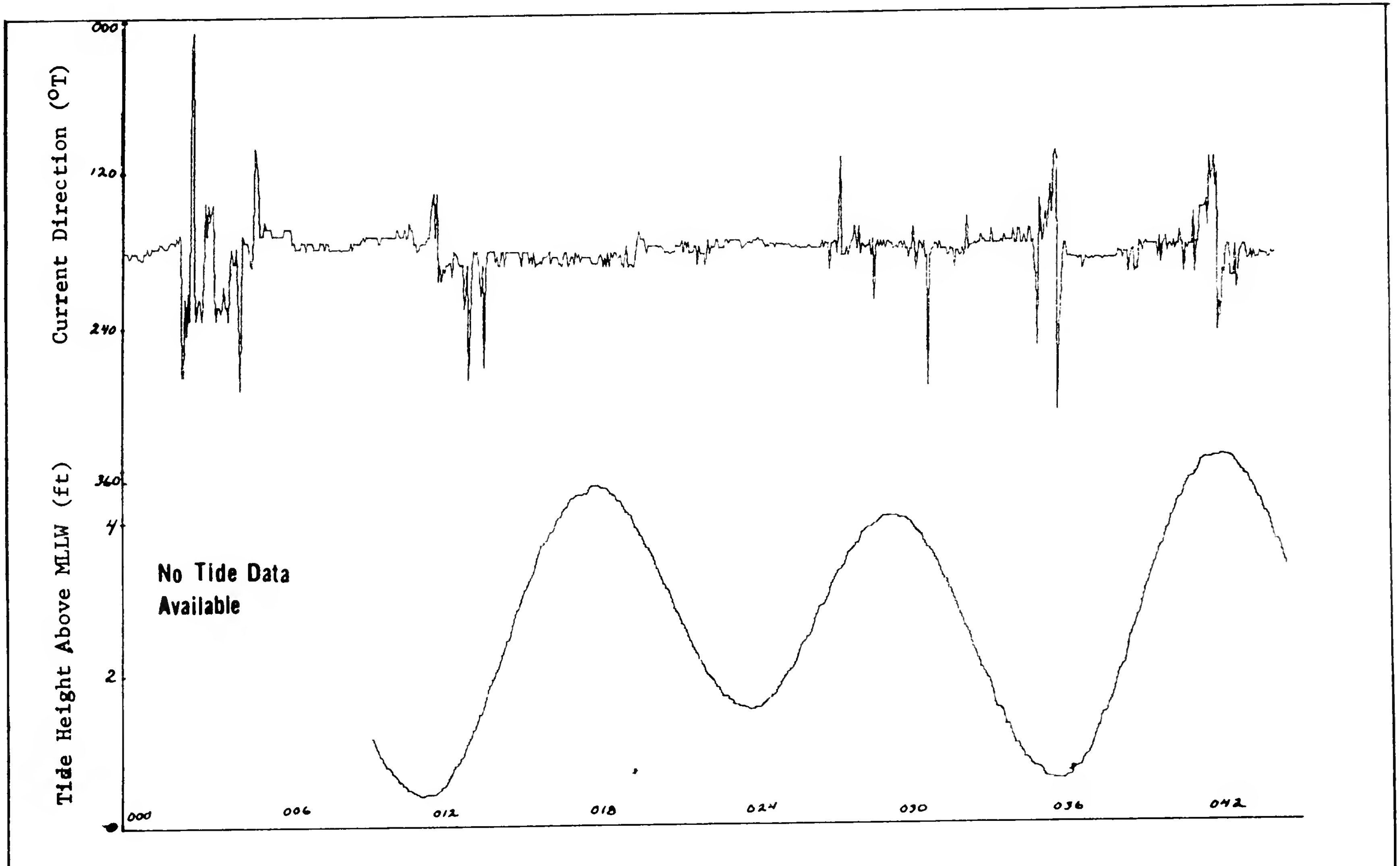


Figure 34b. 0148 27 April to 2248 28 April 1969

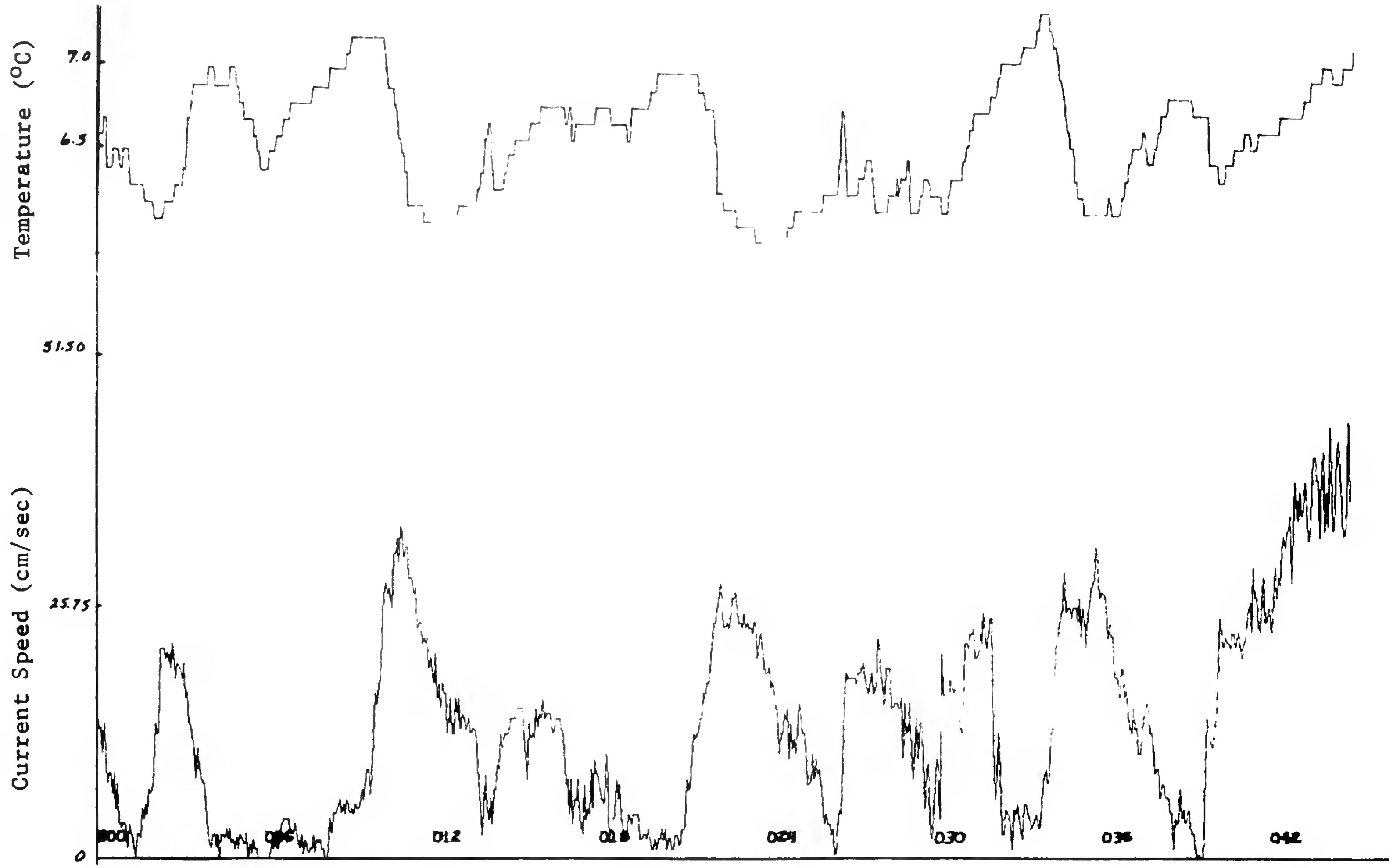


Figure 35a. 2248 28 April to 1948 30 April 1969

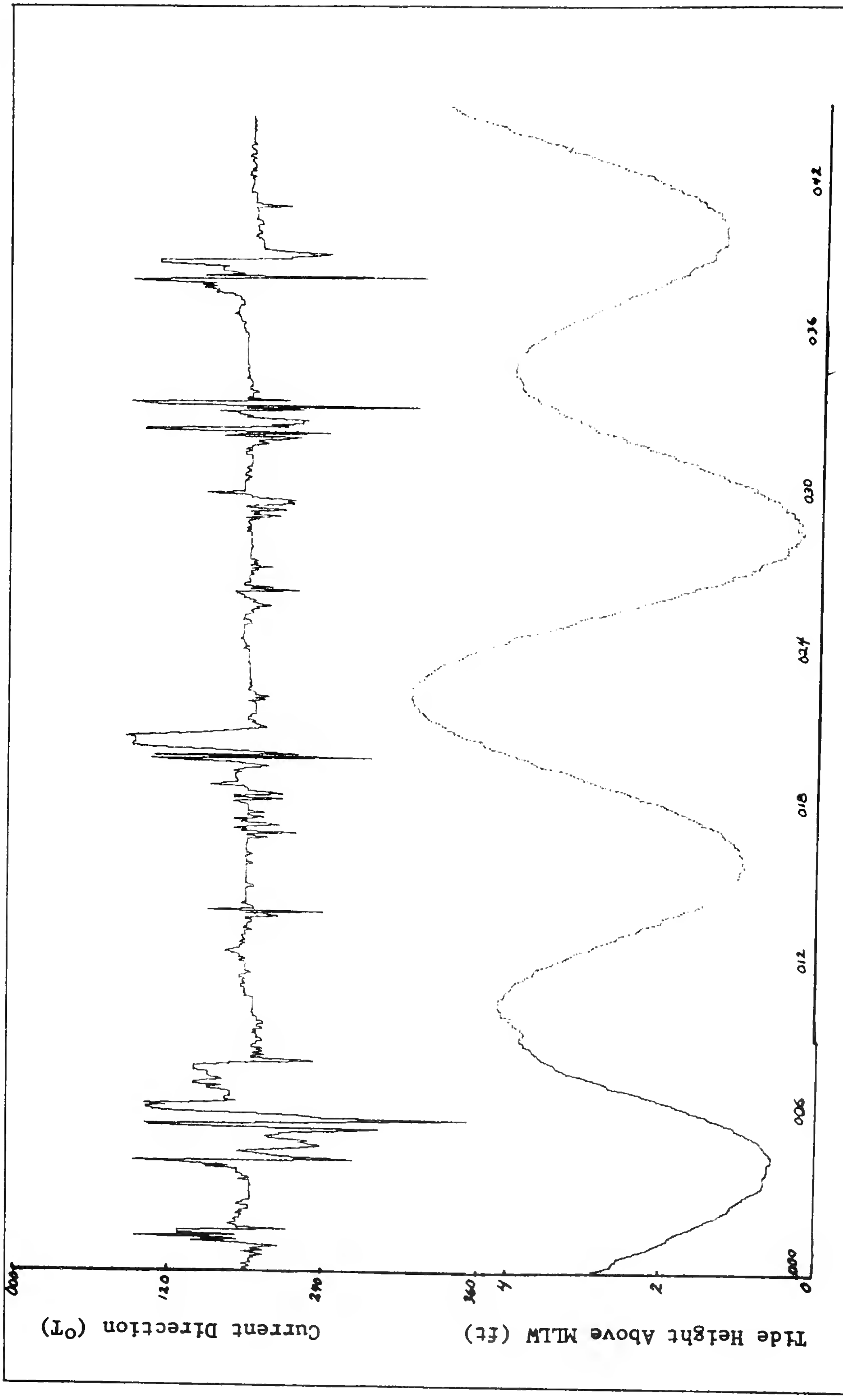


Figure 35b. 2248 28 April to 1948 30 April 1969

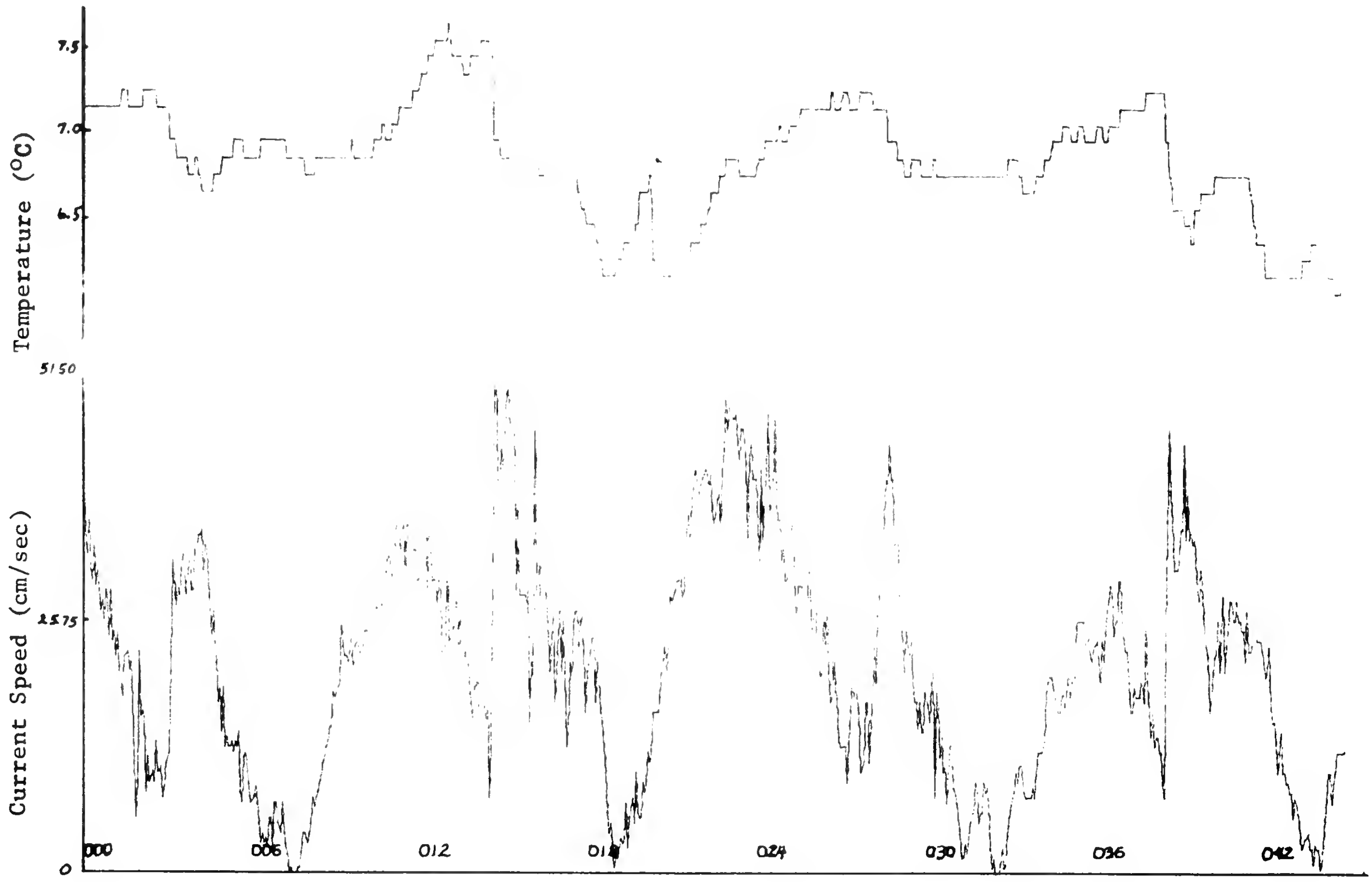


Figure 36a. 1948 30 April to 1648 2 May 1969

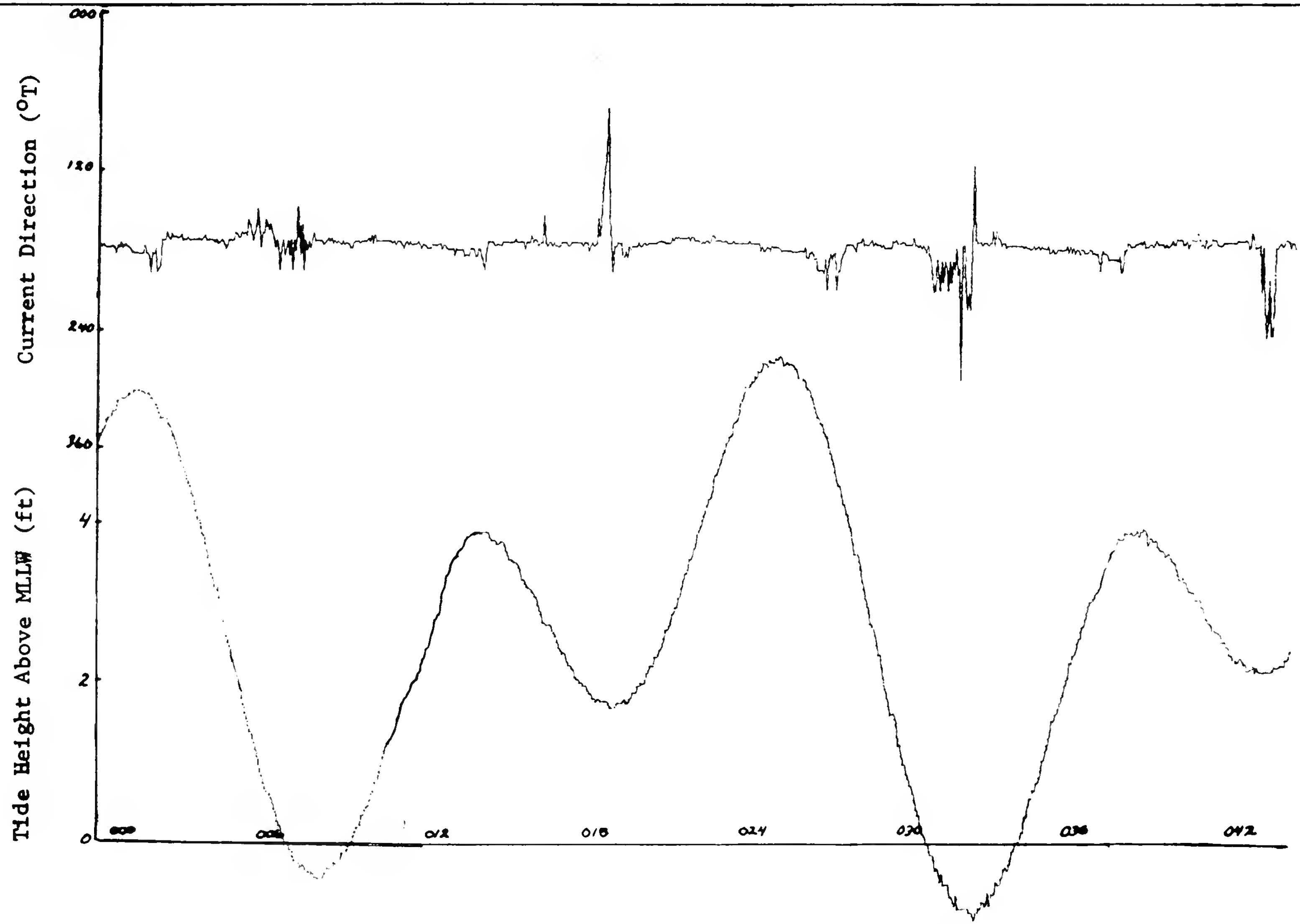


Figure 36b. 1948 30 April to 1648 2 May 1969

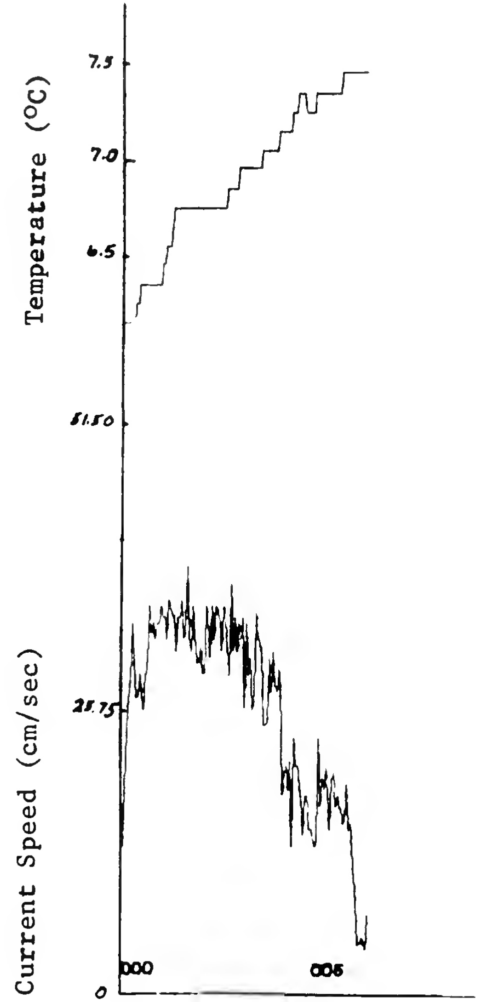


Figure 37a. 1648 2 May to 0033 3 May 1969

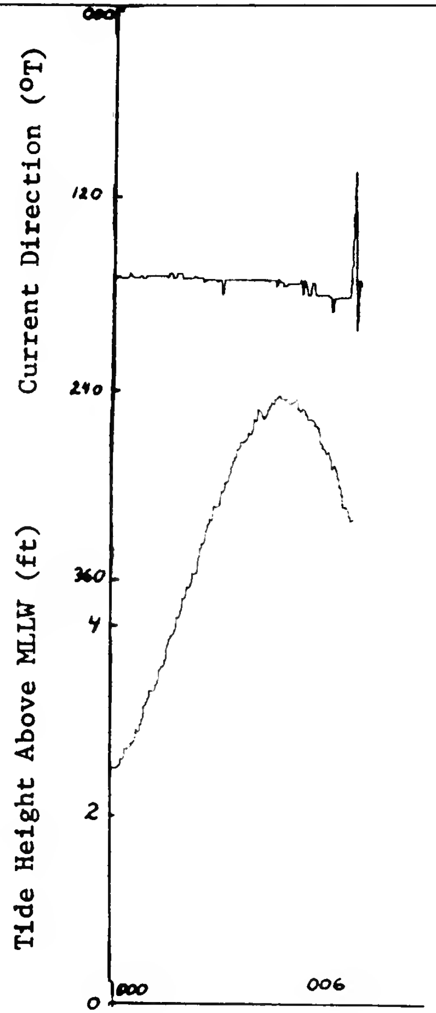


Figure 37b. 1648 2 May to 0033 3 May 1969

APPENDIX C

SCATTER DIAGRAMS OF DOOLEY'S AND NJUS' DATA

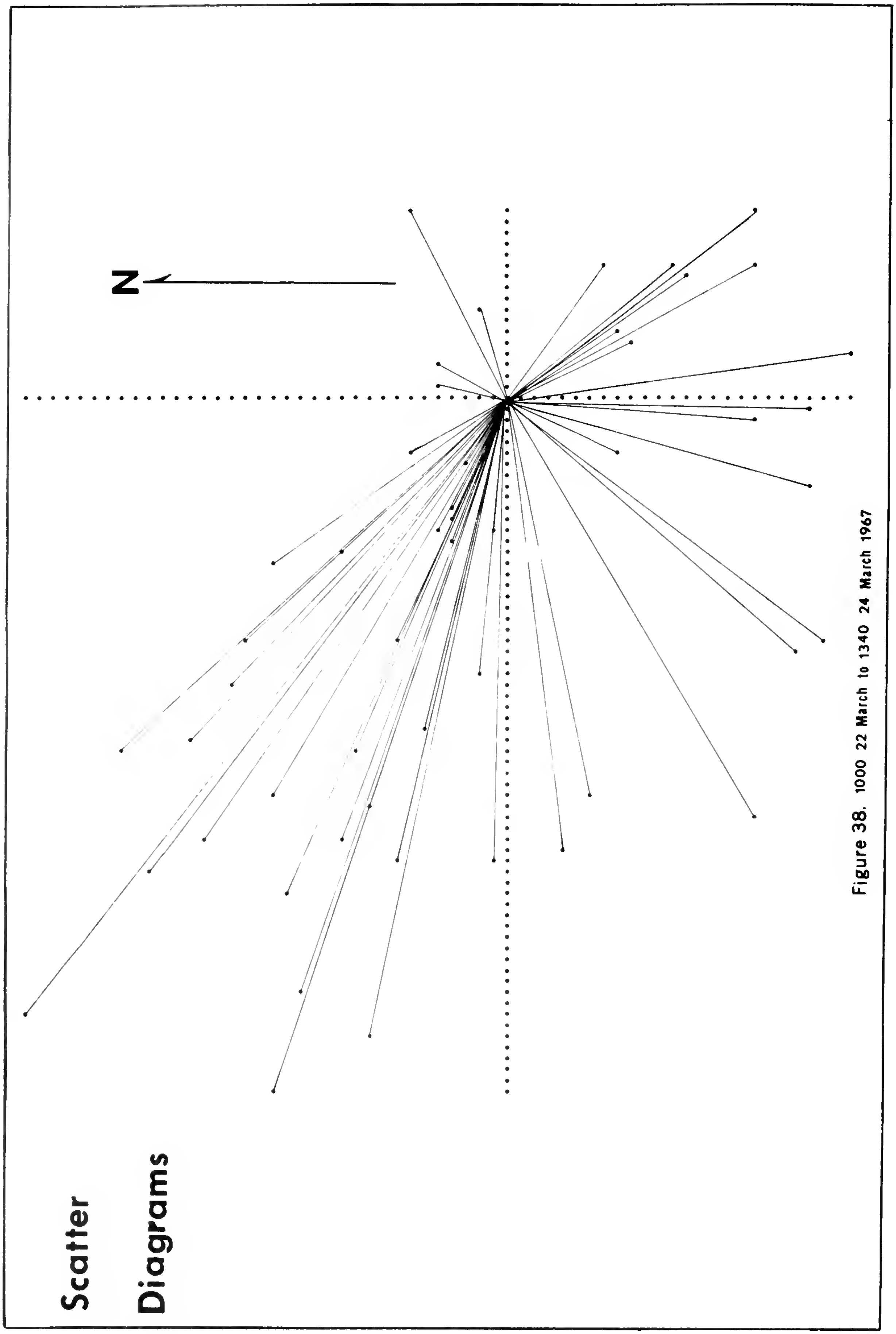


Figure 38. 1000 22 March to 1340 24 March 1967

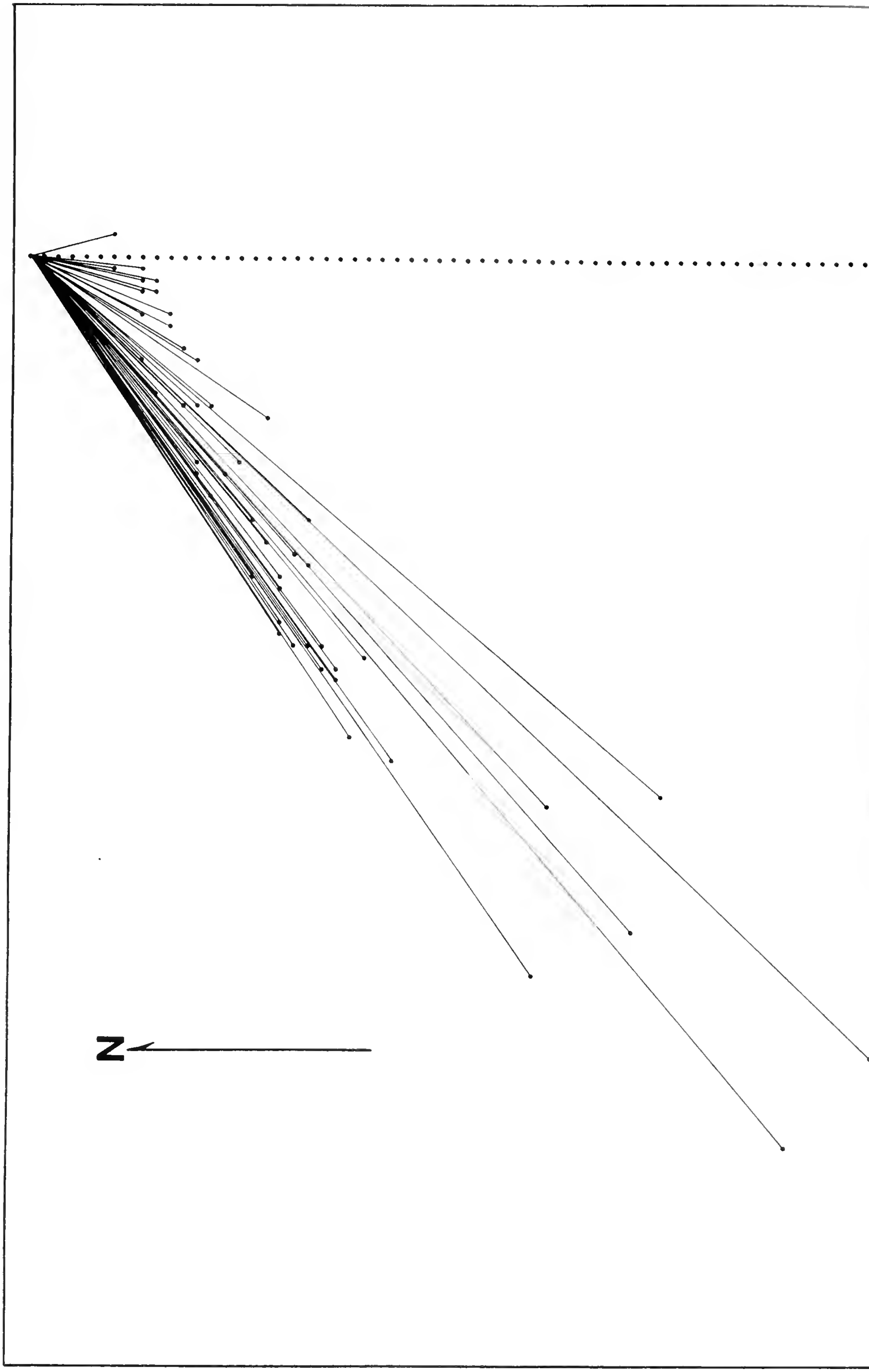


Figure 39. 24 November to 26 November 1968

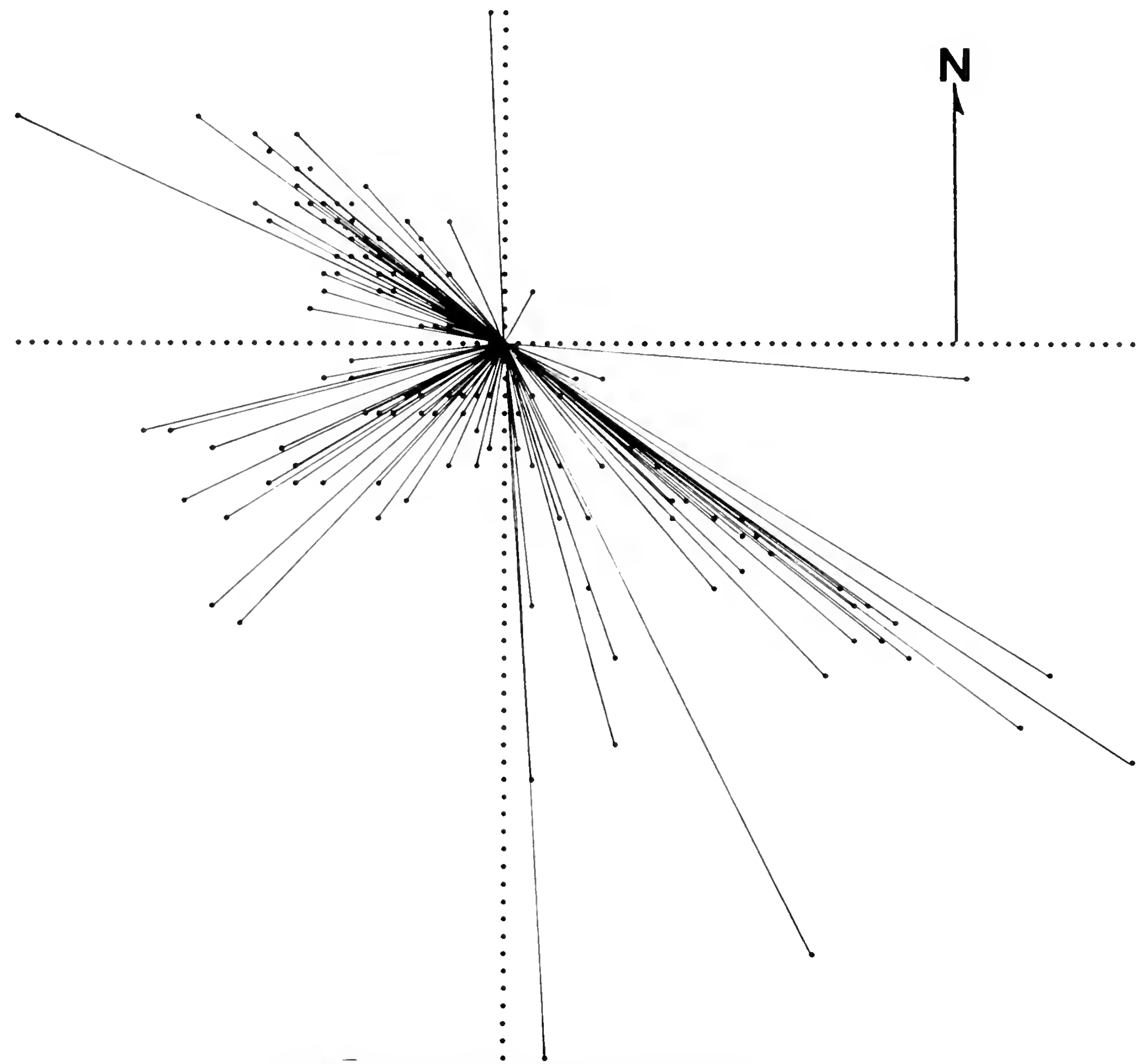


Figure 40. 1426 15 January to 2326 21 January 1968

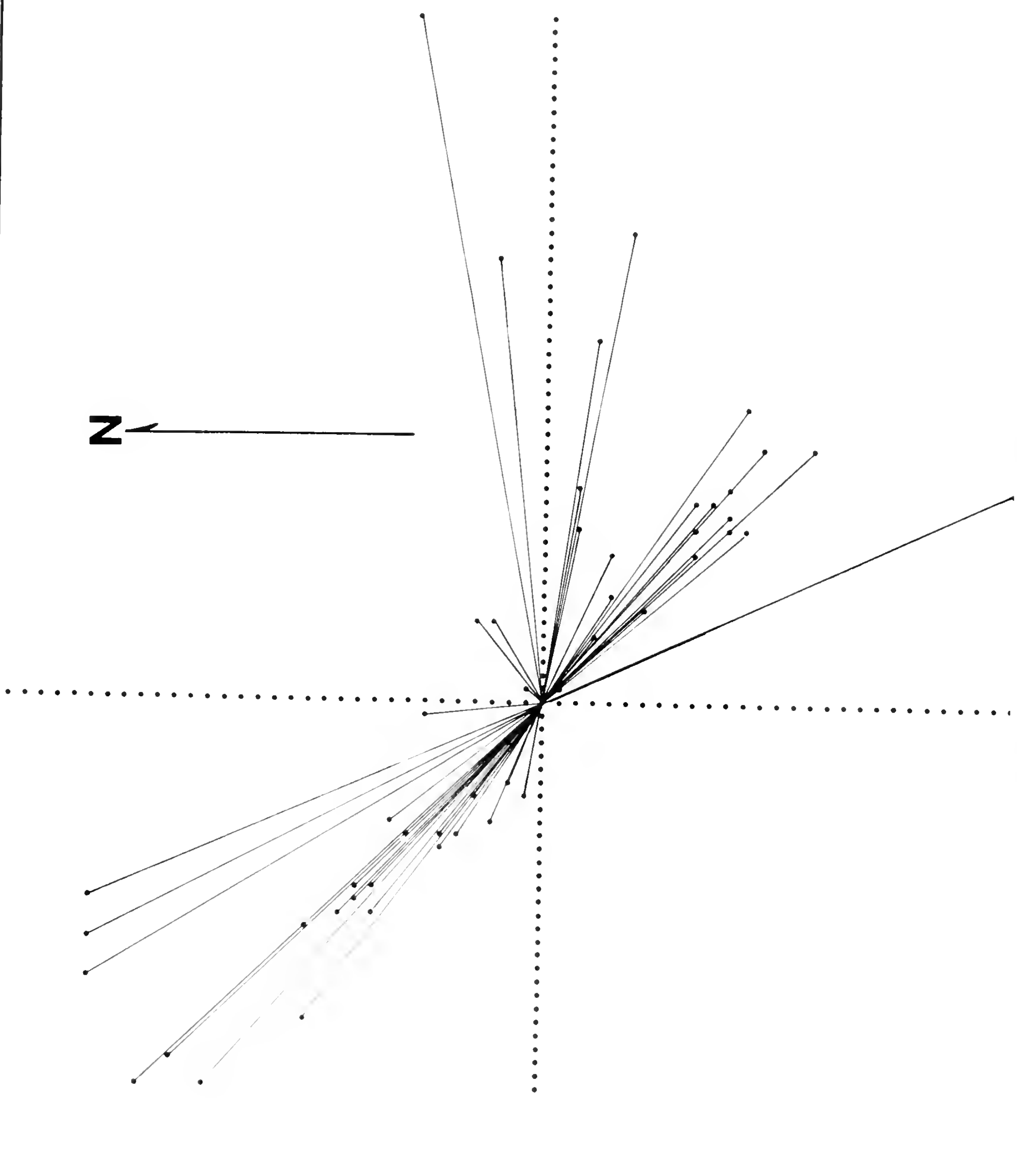


Figure 41. 0945 29 Febuary to 1410 2 March 1968

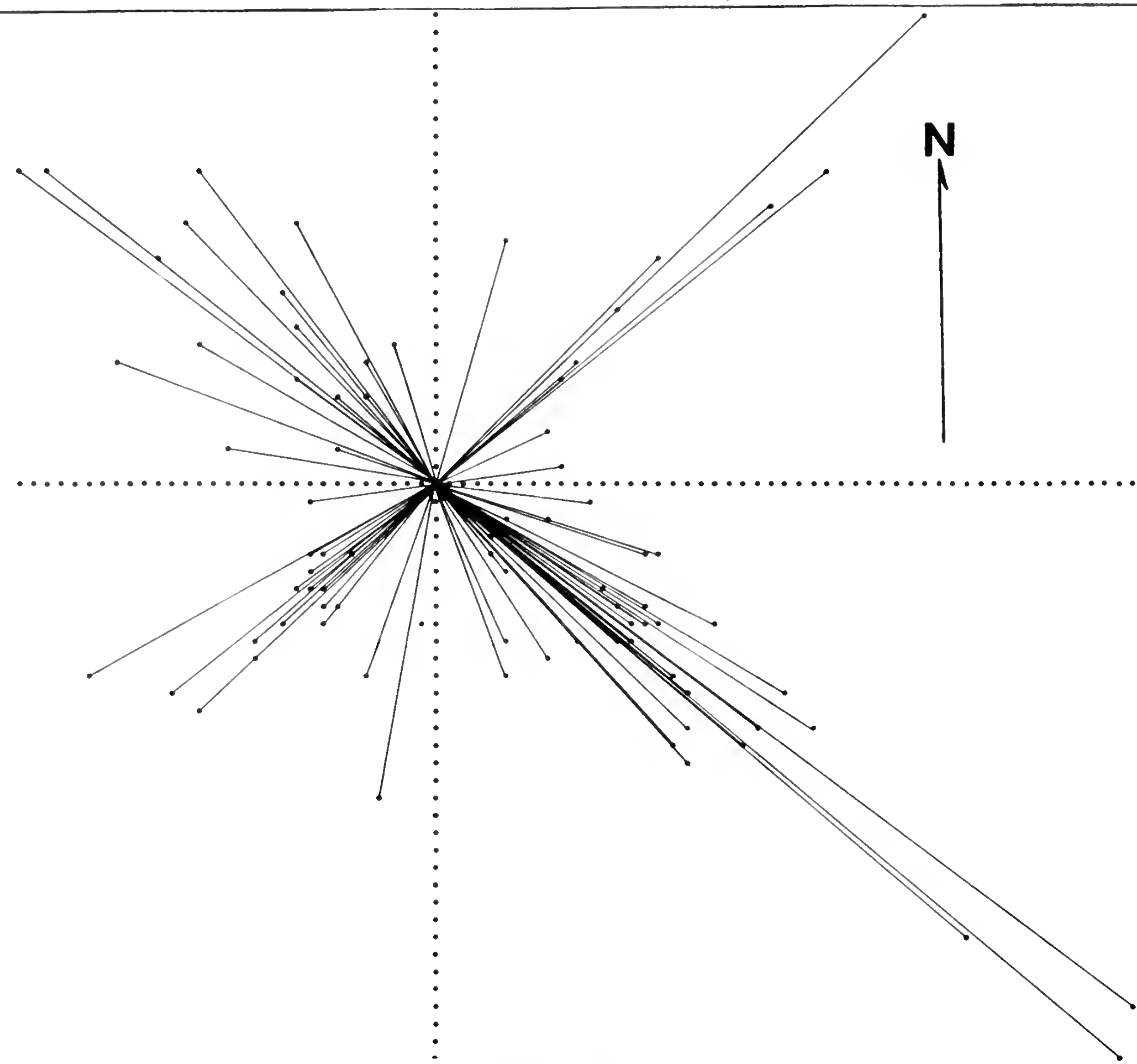


Figure 42. 1520 14 May to 1526 21 May 1968

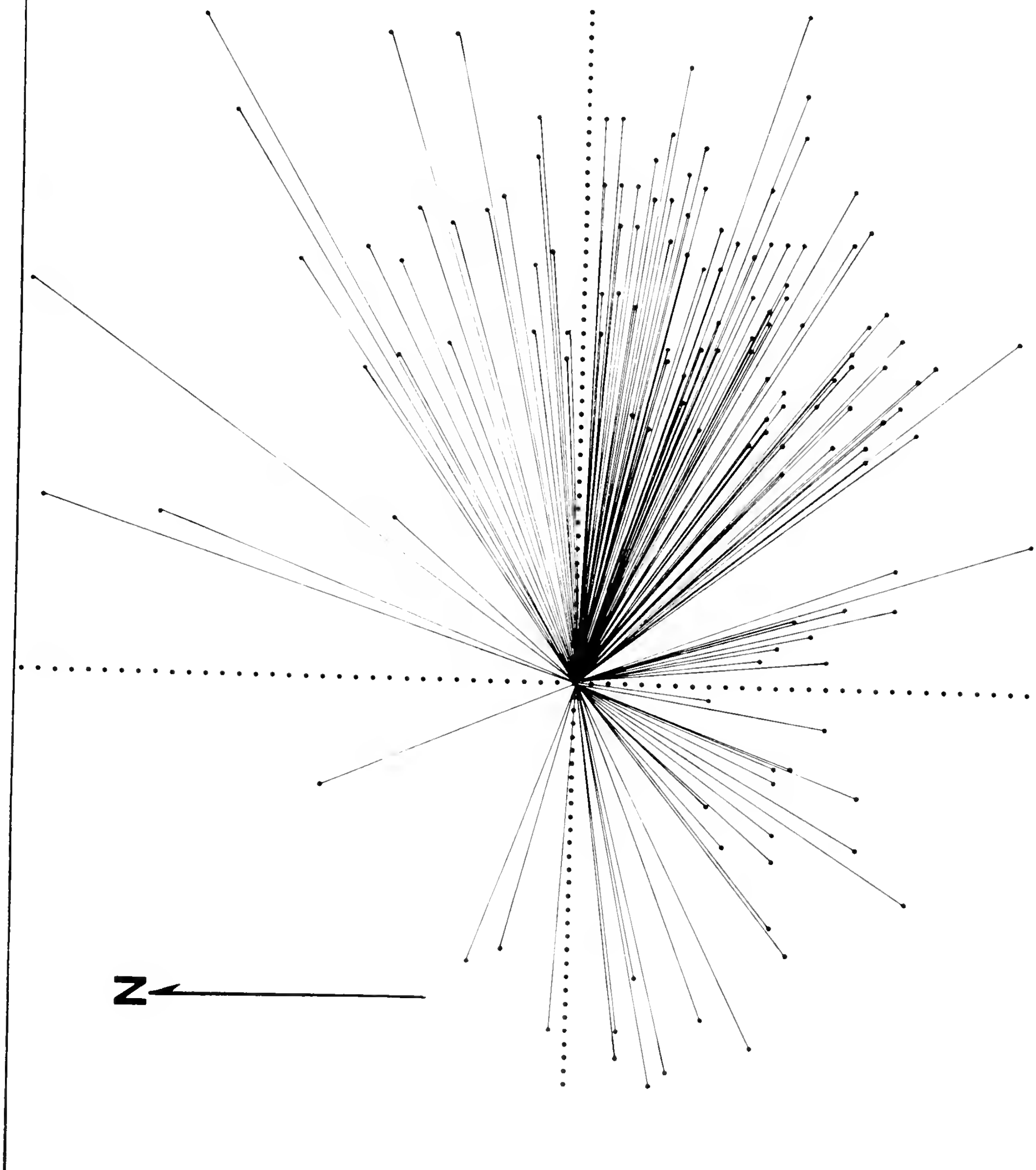


Figure 43. 1230 26 September to 1250 3 October 1968

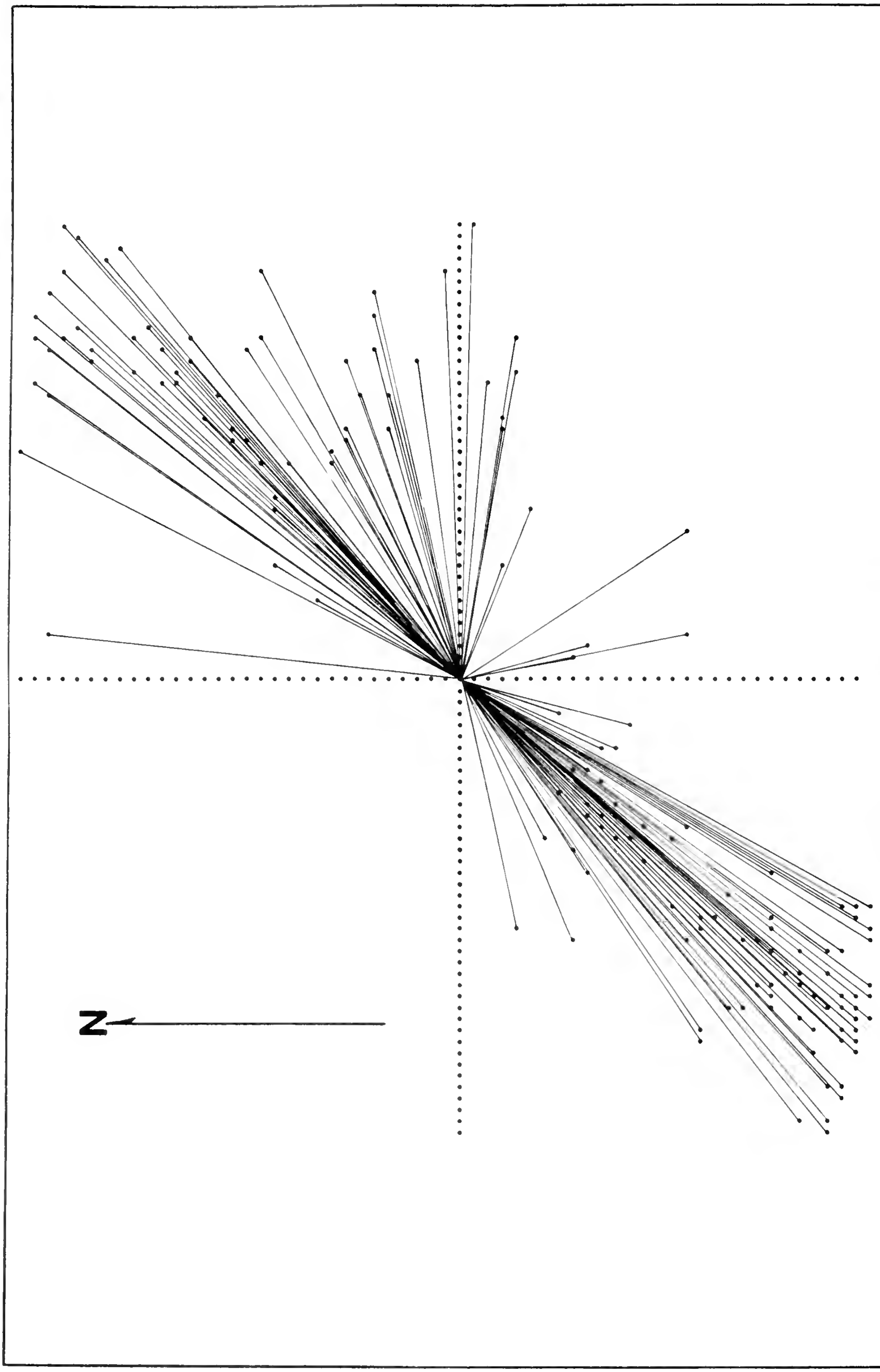


Figure 44. 1050 17 October to 0950 24 October 1968

APPENDIX D
PROGRESSIVE VECTOR DIAGRAMS OF
DOOLEY'S AND NJUS' DATA

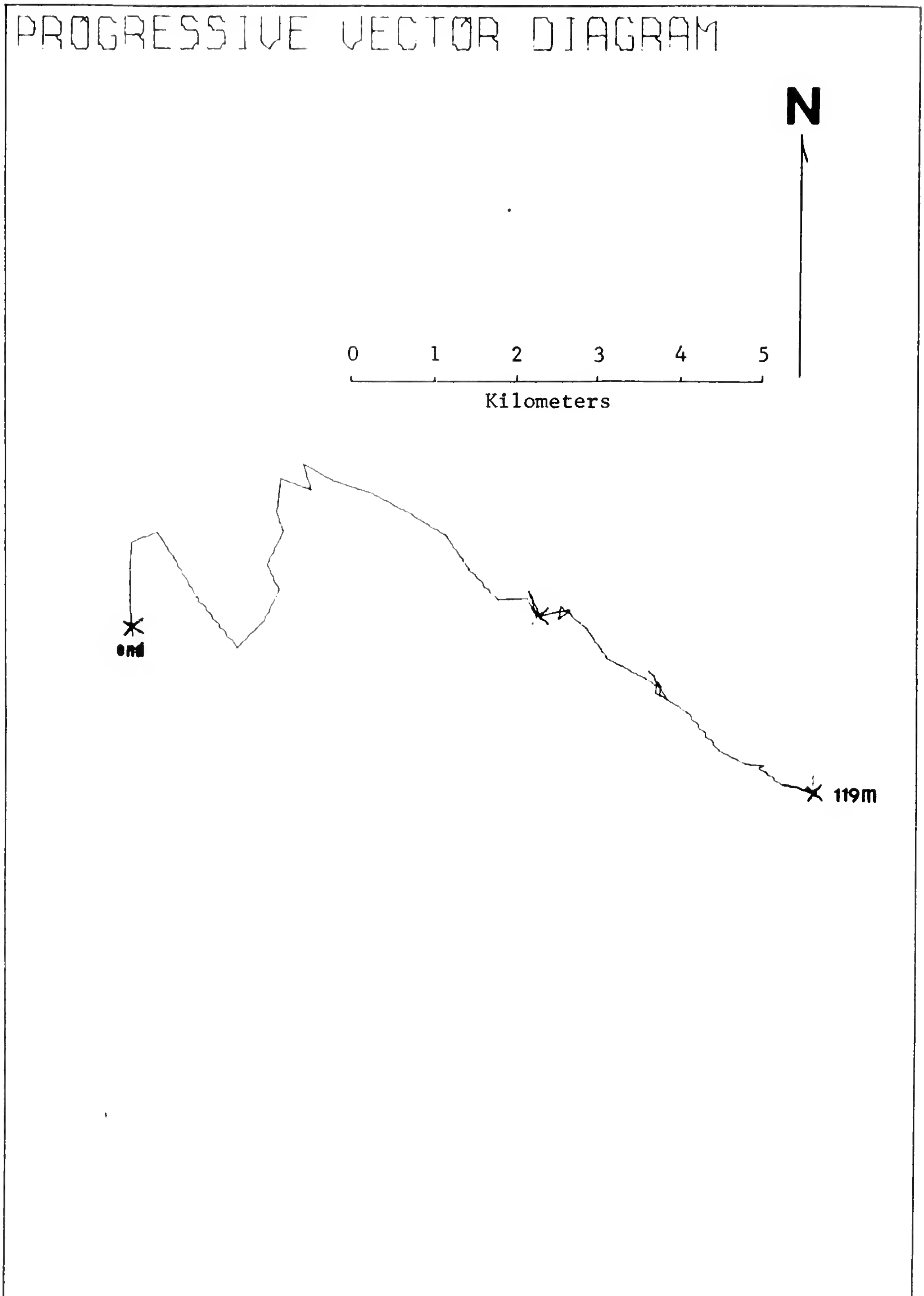


Figure 45. 1000 22 March to 1340 24 March 1967

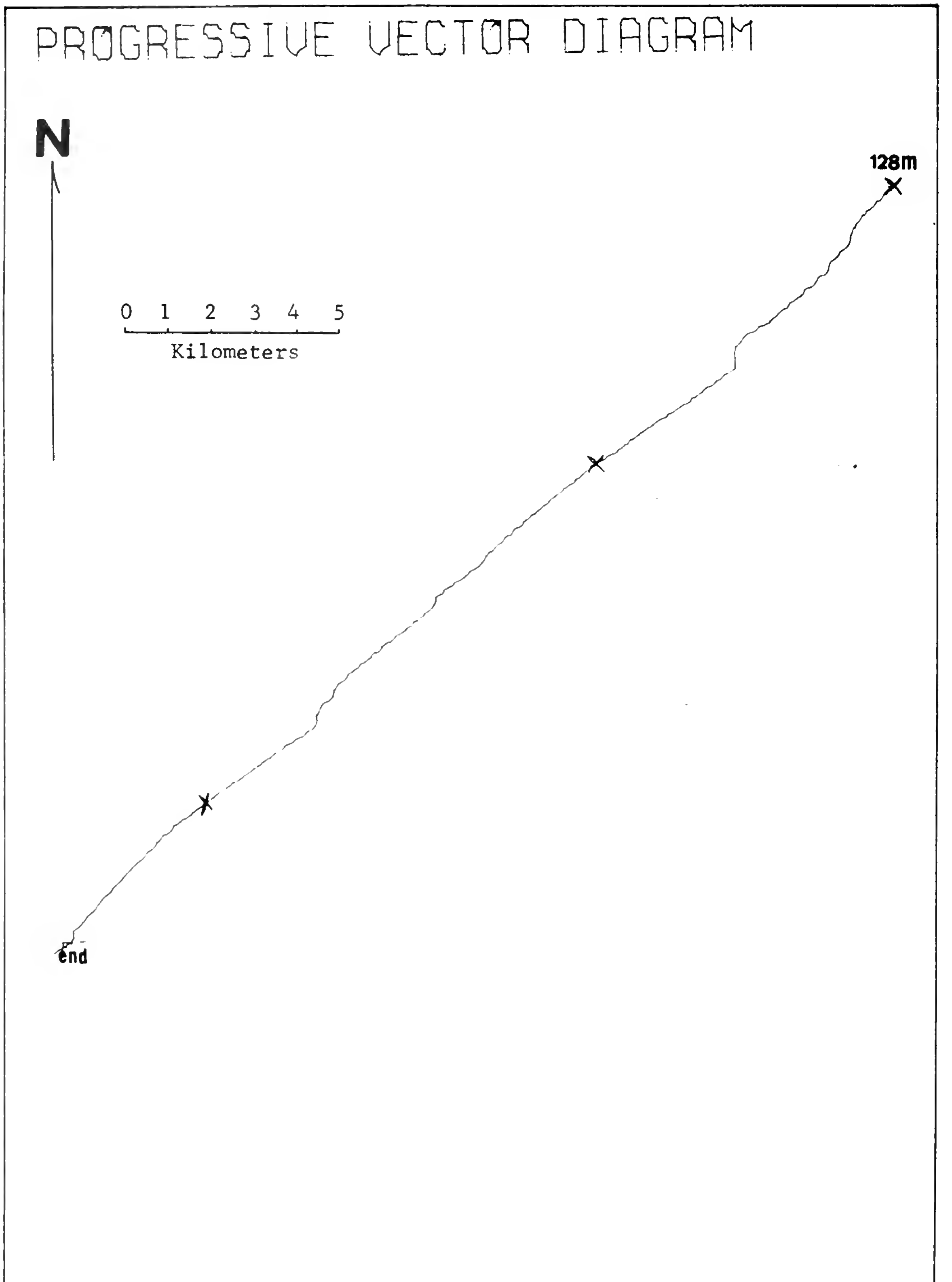


Figure 46. 1110 24 November to 2210 26 November 1967

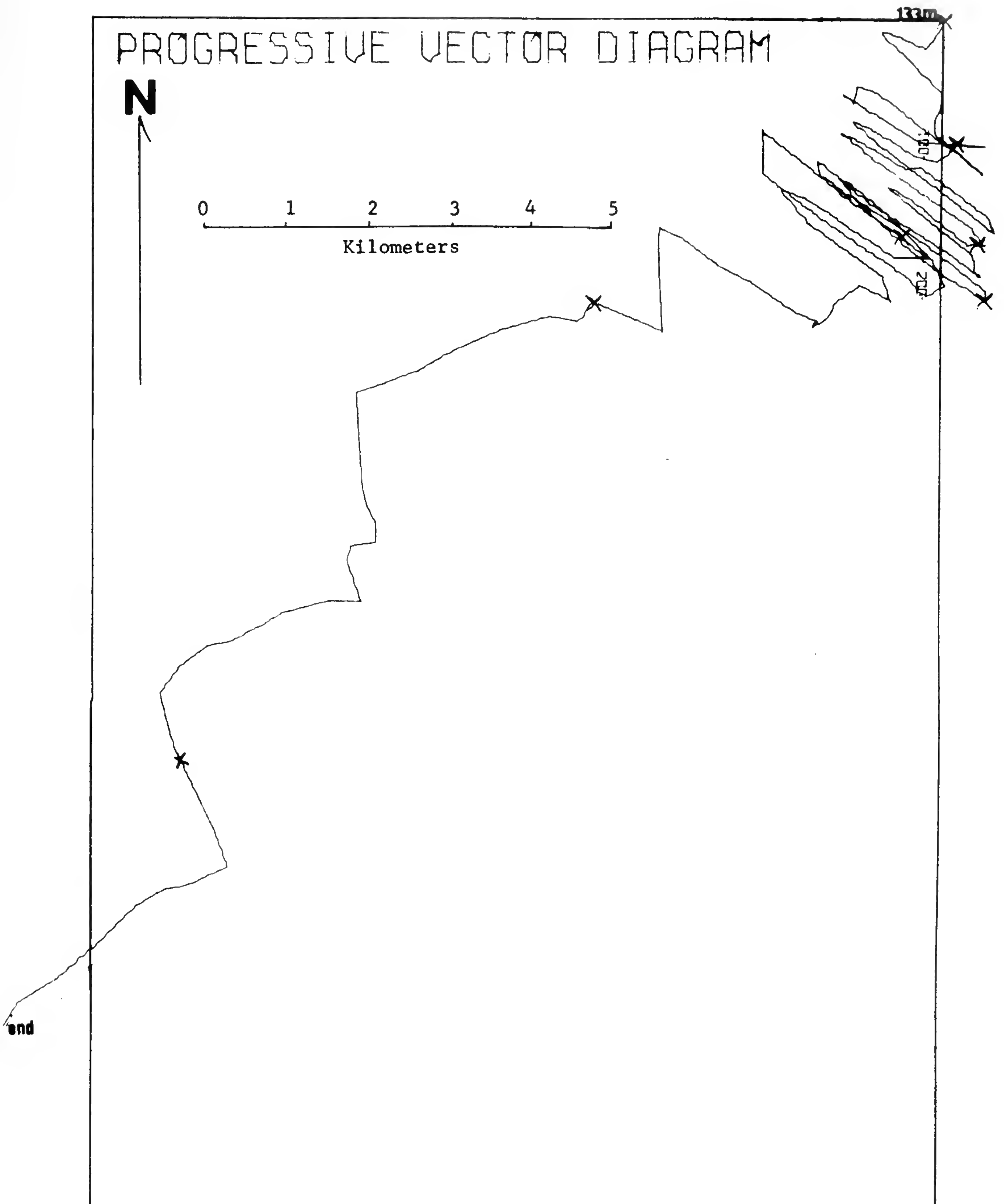


Figure 47. 1426 15 January to 2326 21 January 1968

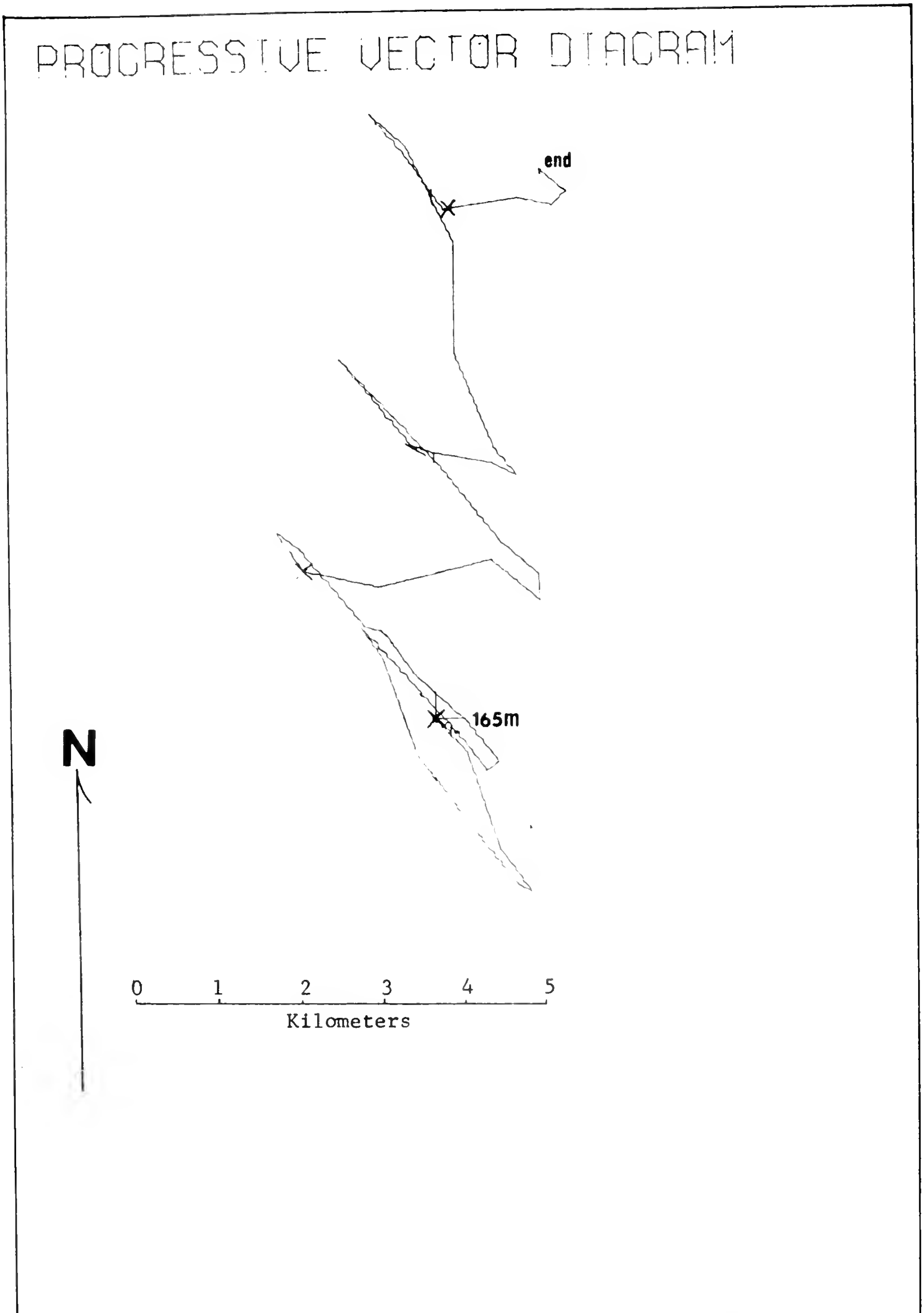


Figure 48. 0945 29 February to 1410 2 March 1968

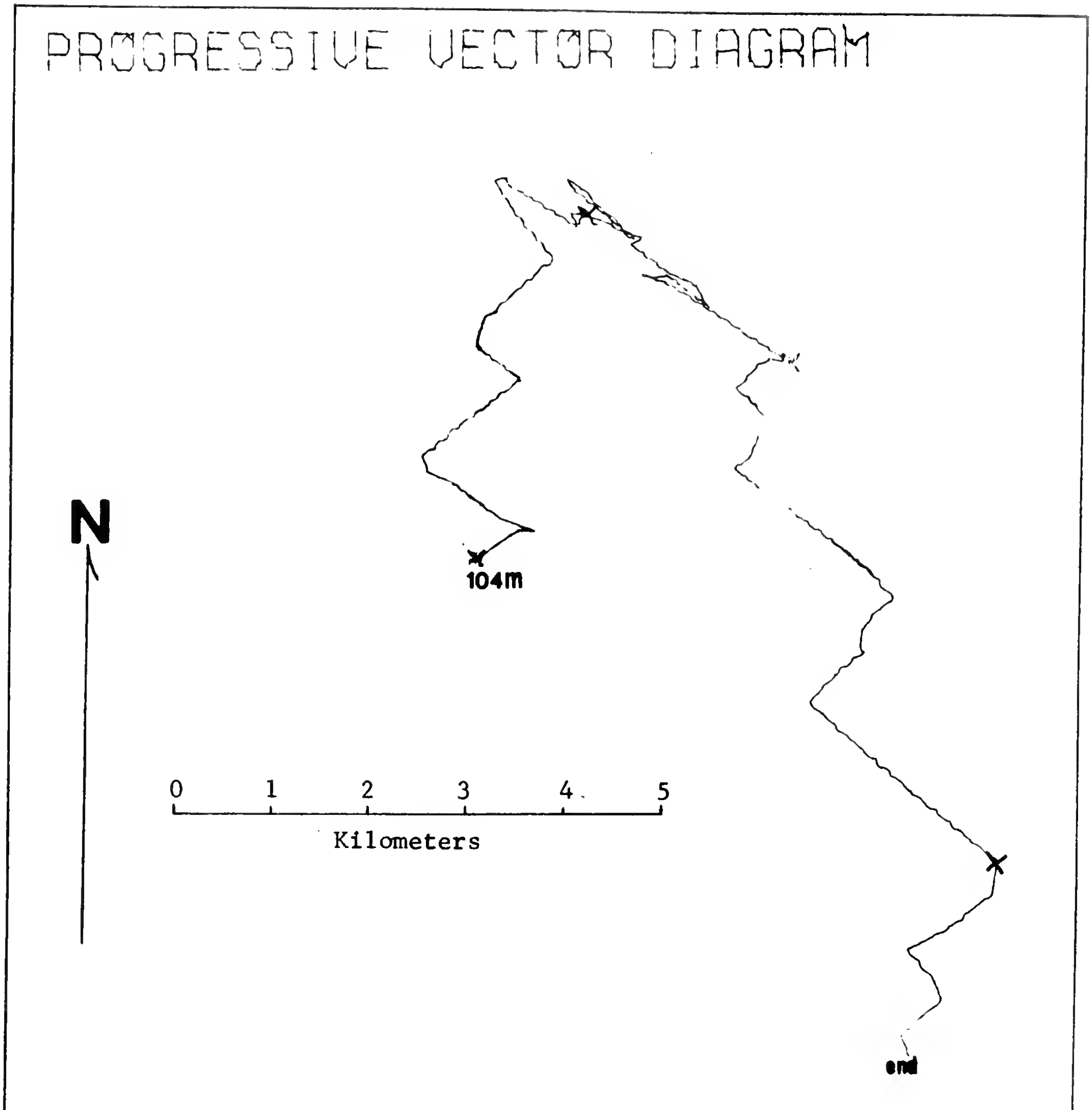


Figure 49. 1520 14 May to 1526 21 May 1968

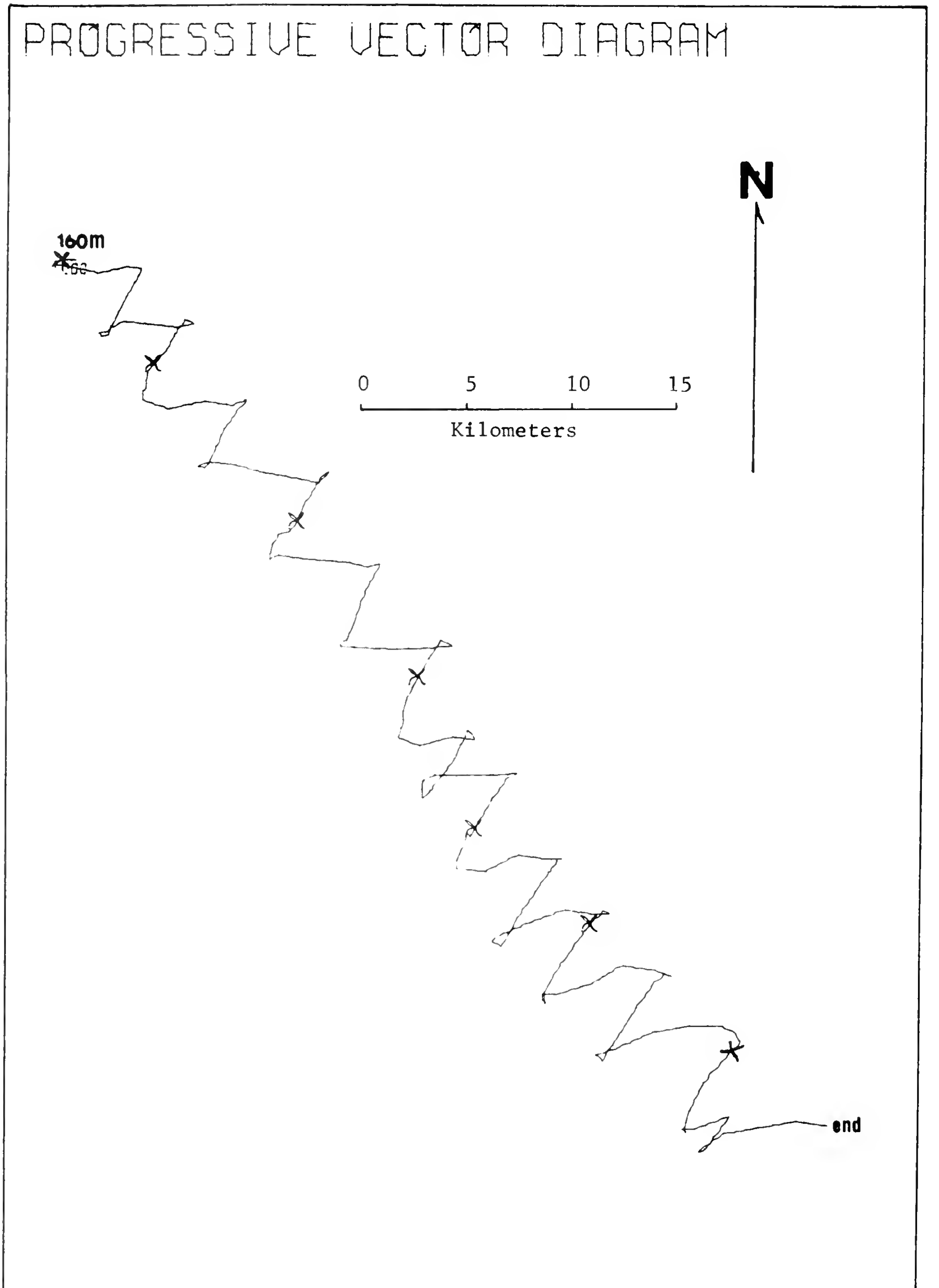


Figure 50. 1230 26 September to 1250 3 Oct 1968

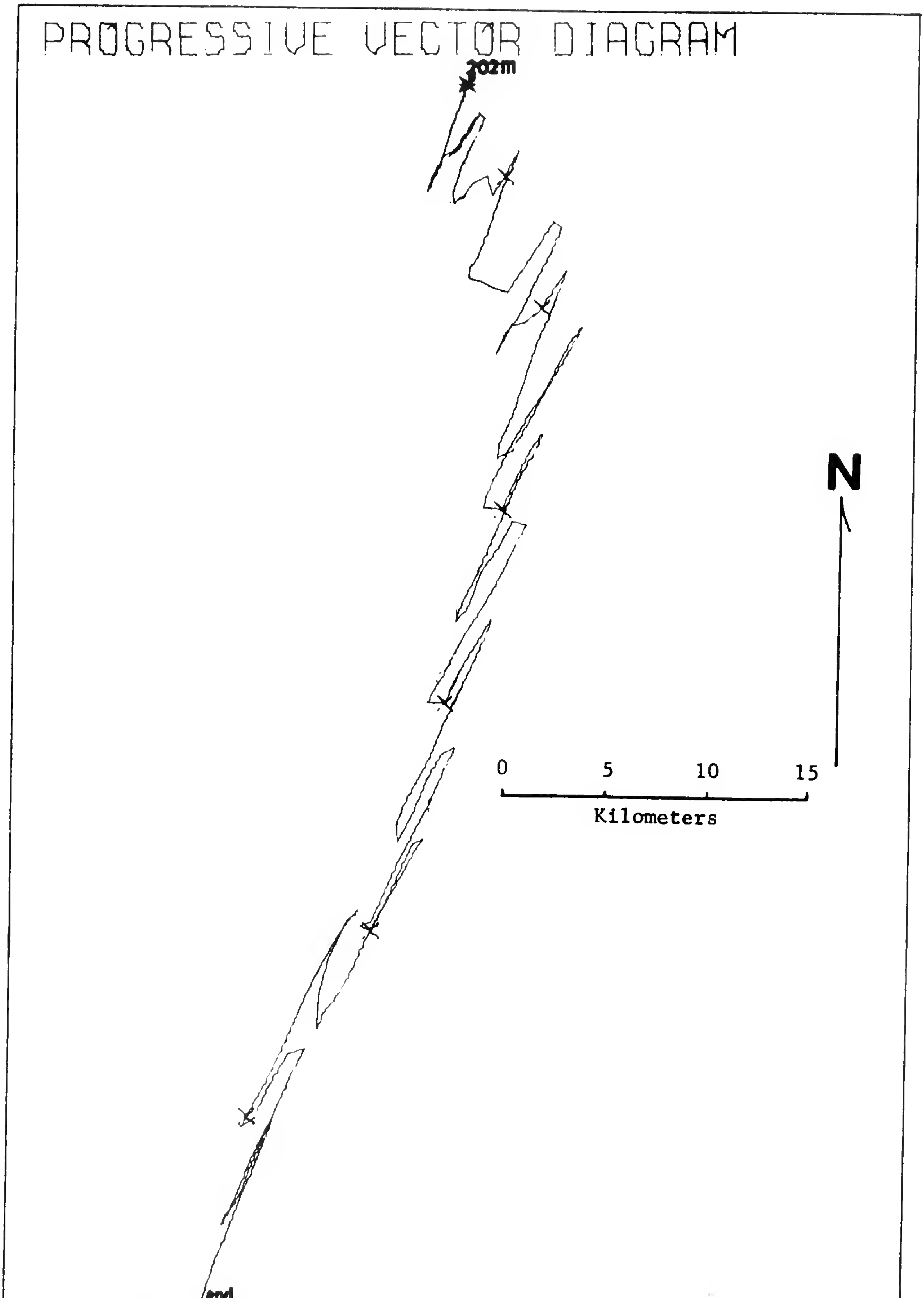


Figure 51. 1050 17 October to 0950 24 October 1968

APPENDIX E
SPECTRAL ESTIMATES OF
DOOLEY'S AND NJUS' DATA

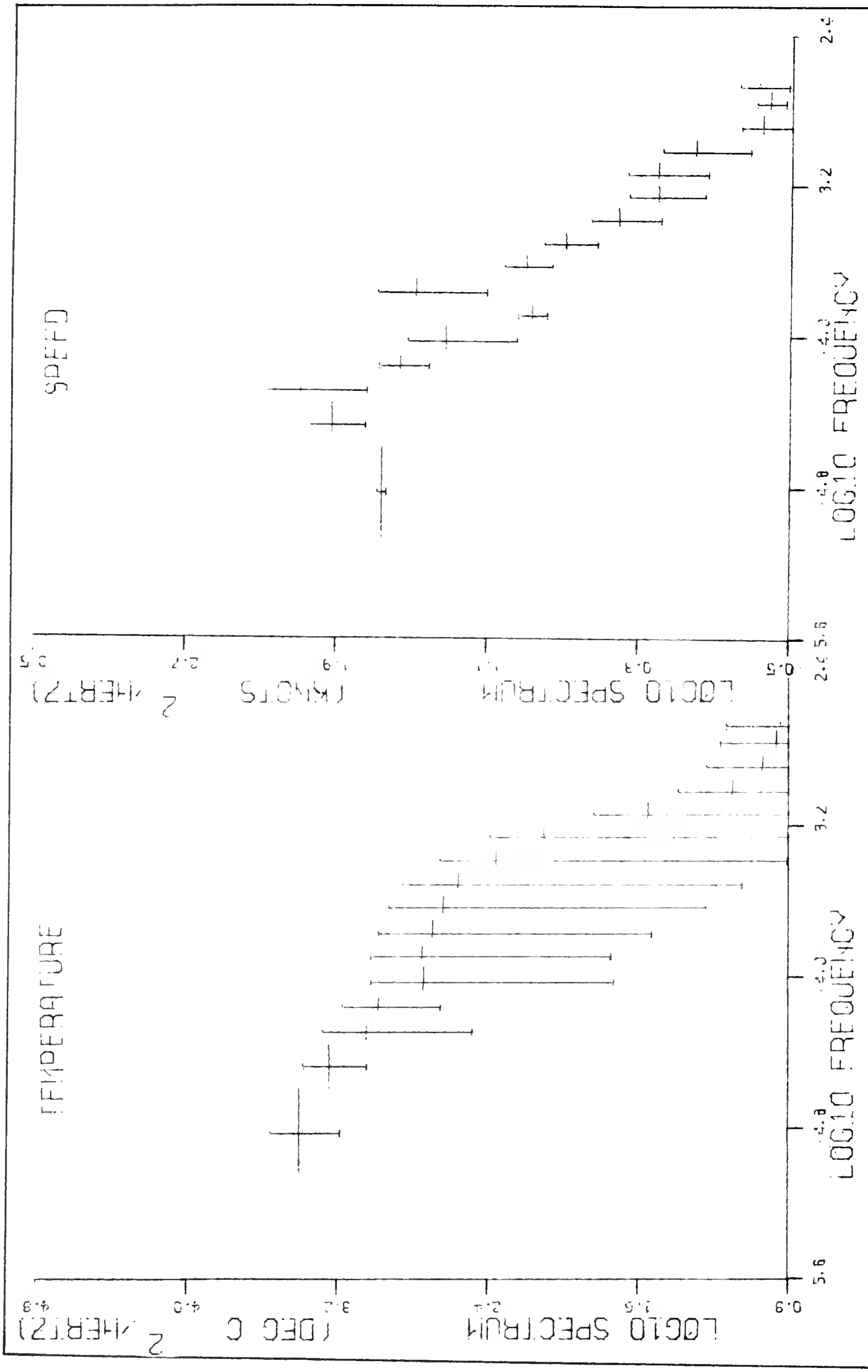


Figure 52. 1000 22 March to 1340 24 March 1967

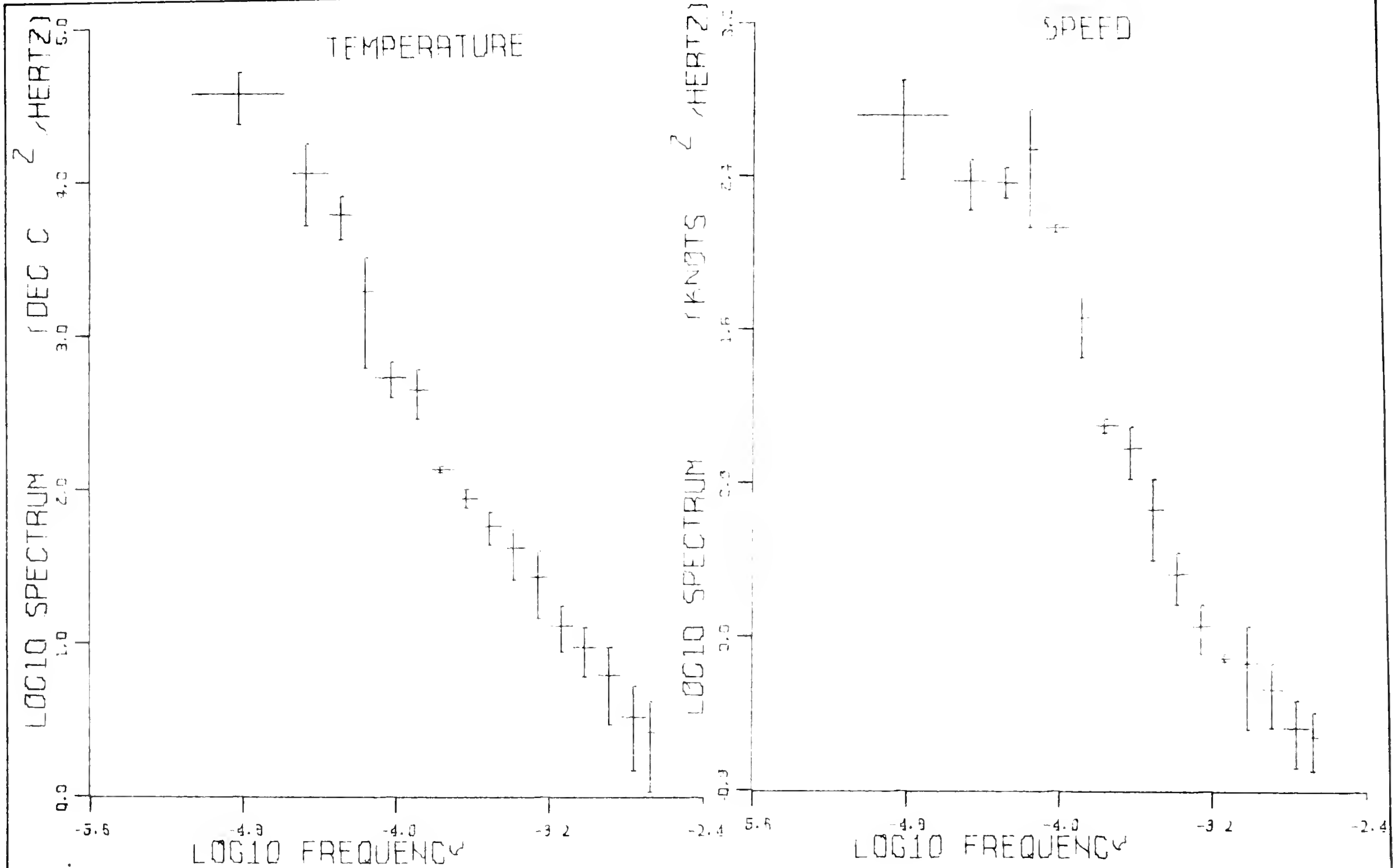


Figure 53. 1110 24 November to 2210 26 November 1967

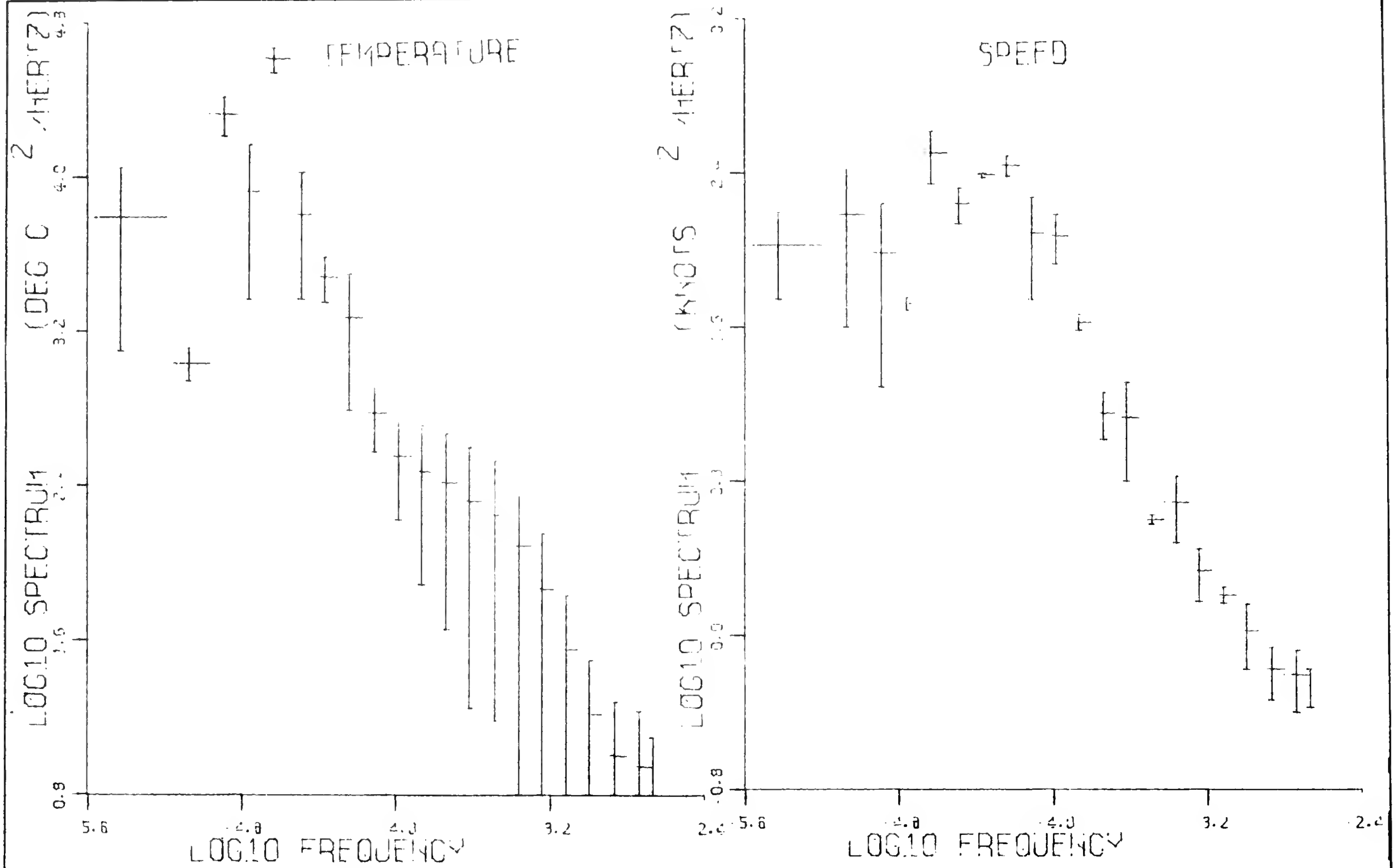


Figure 54. 1426 15 January to 2326 21 January 1968

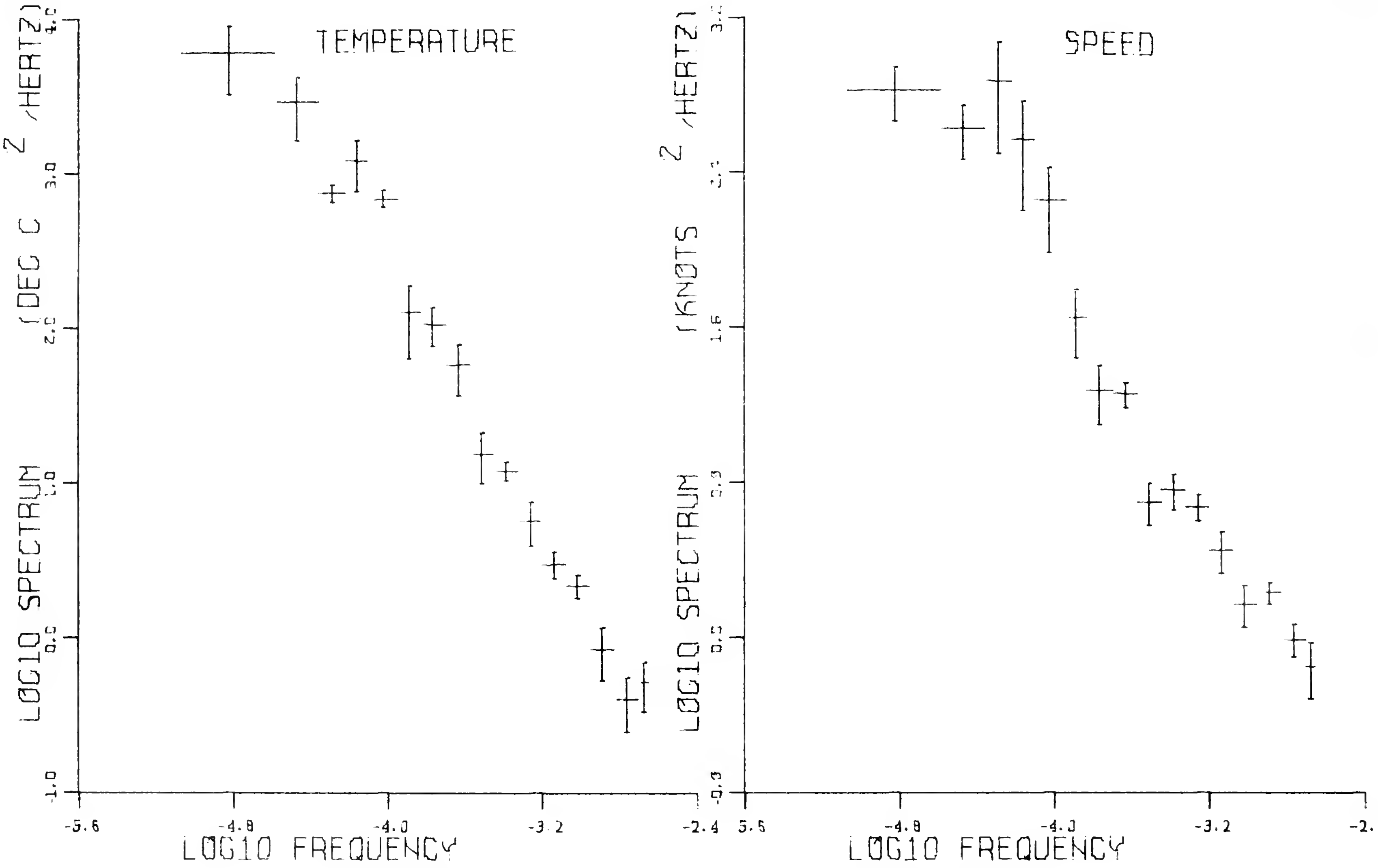


Figure 55. 0945 29 February to 1410 2 March 1968

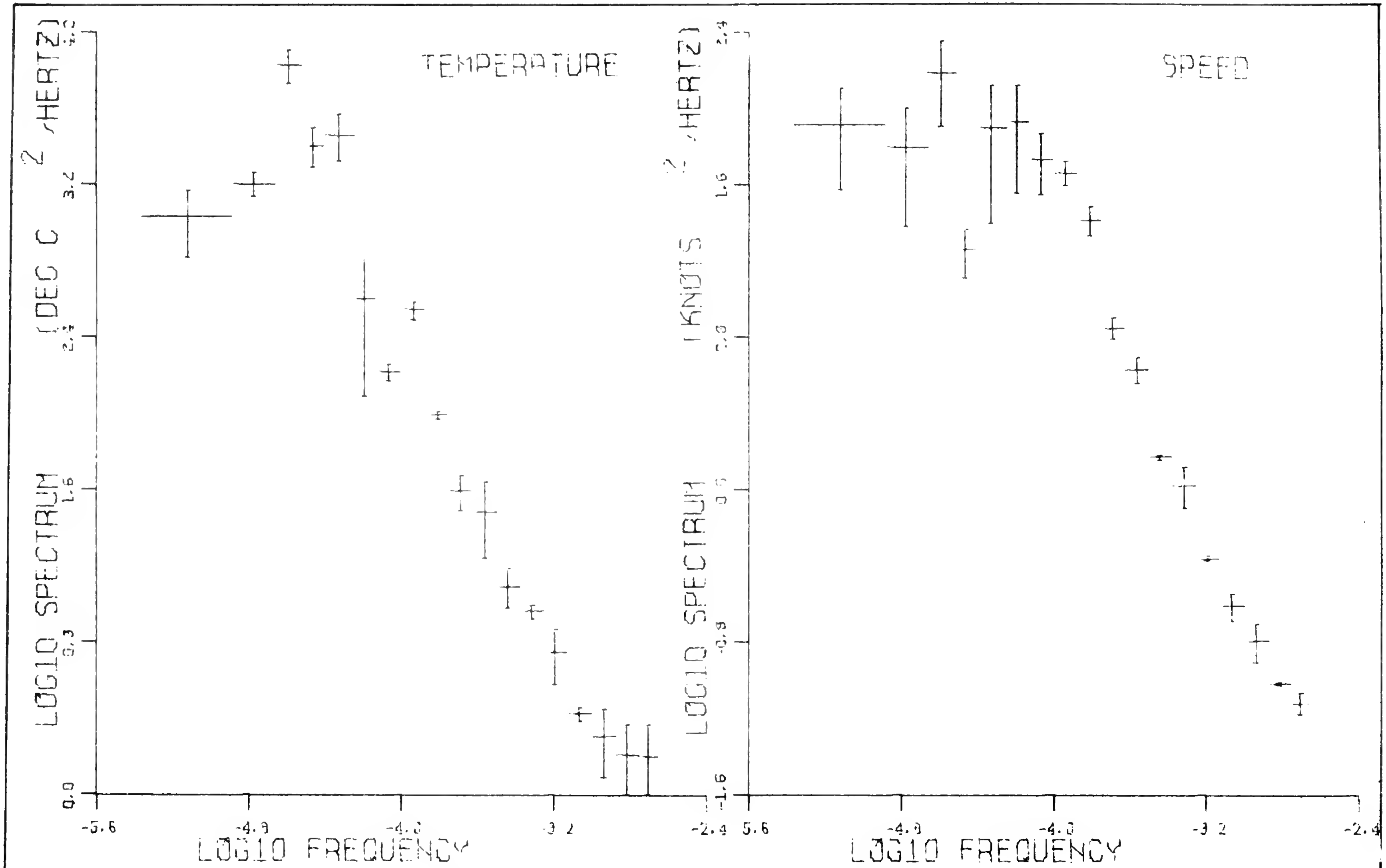


Figure 56. 1520 14 May to 1526 21 May 1968

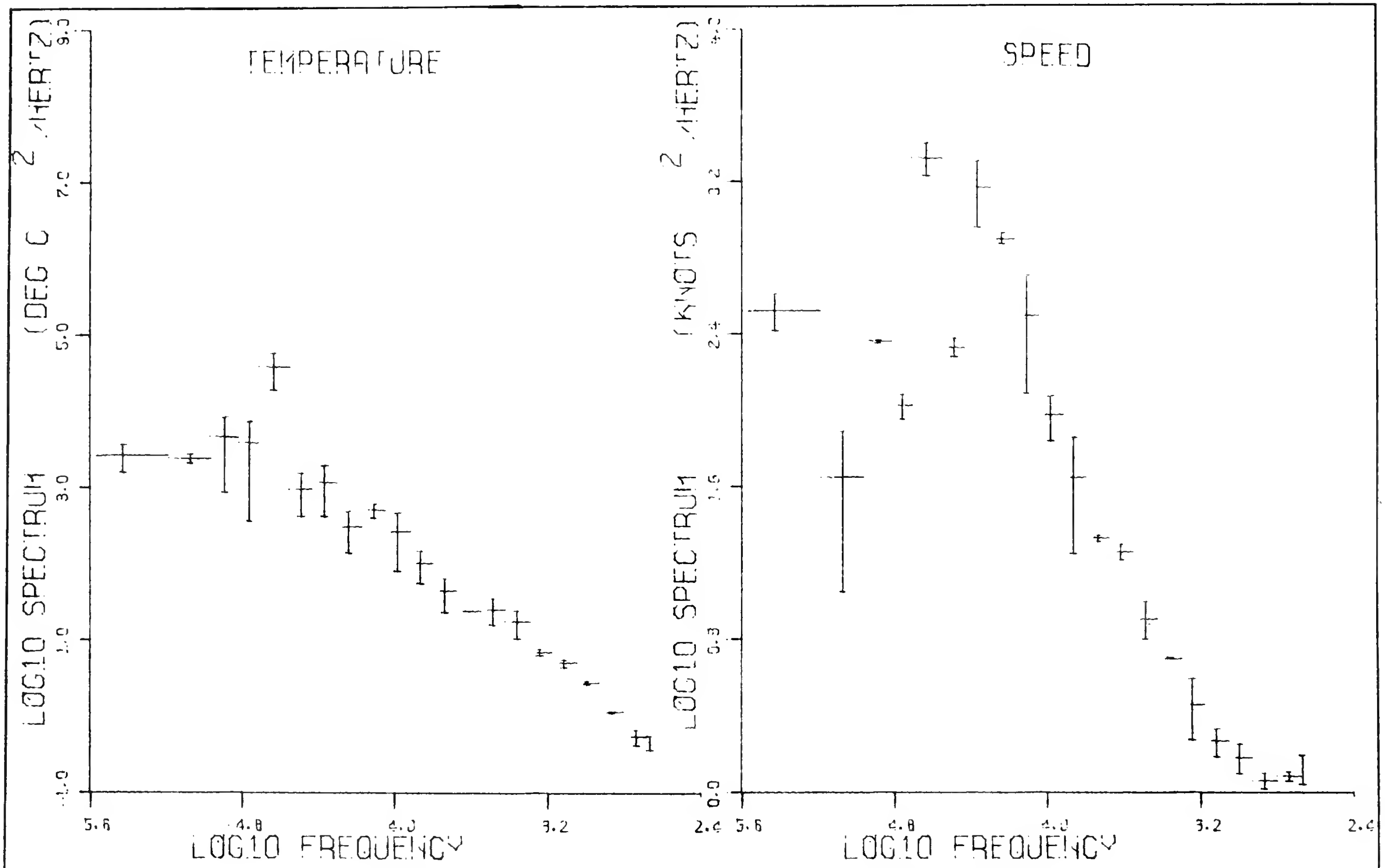


Figure 57. 1230 26 September to 1250 3 October 1968

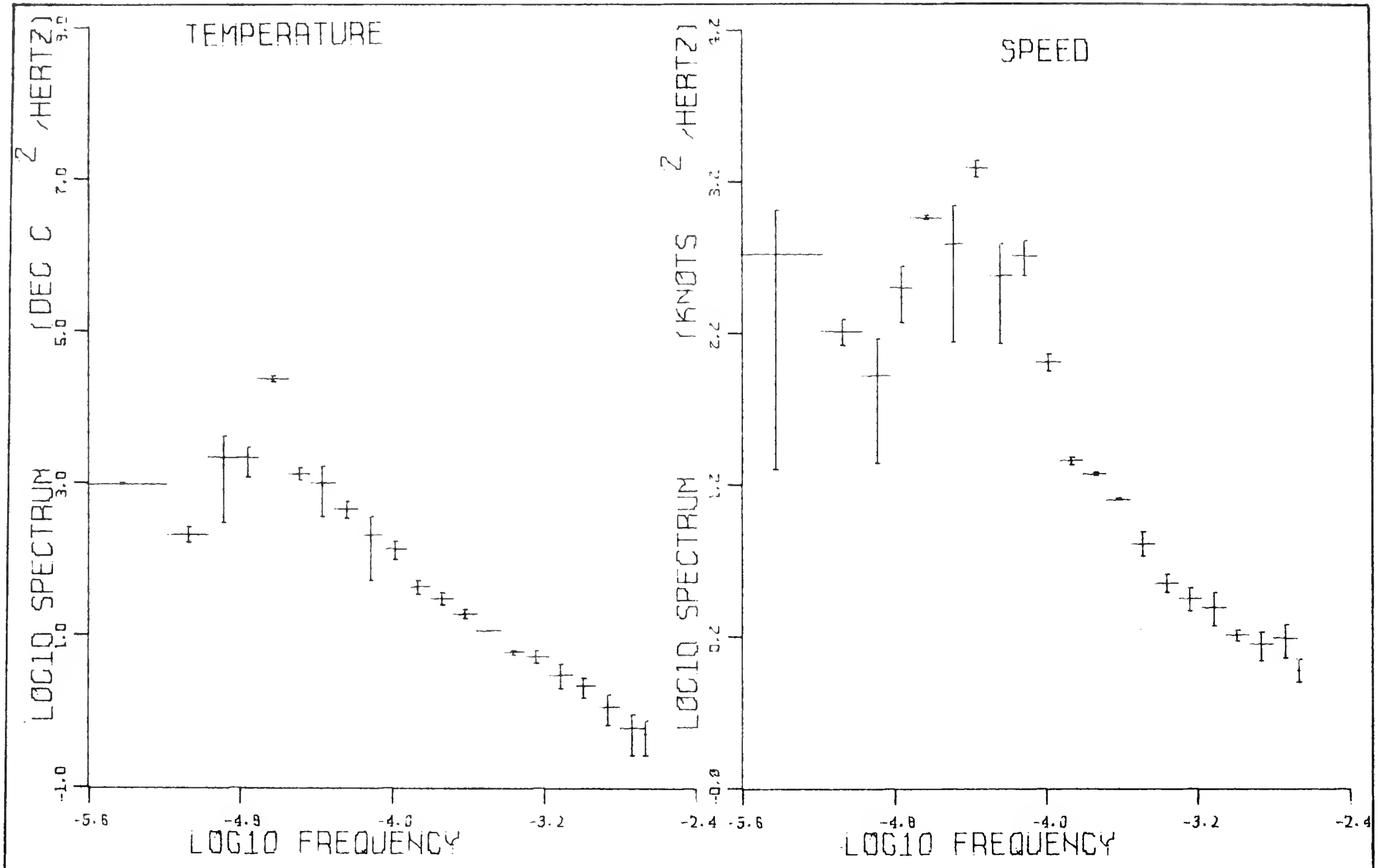


Figure 58. 1050 17 October to 0950 24 October 1968

APPENDIX F

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                       C
      PROGRAM CONVERT
C                                                                       C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
C     THIS PROGRAM CONVERTS THE DIGITIZED RECORDS OF THE NAVAL POSTGRADUATE
C     SCHOOL TIDE GAUGE, LOCATED ON WHARF NO. 2 IN MONTEREY HARBOR, FROM
C     EXTERNAL BCD TO AMPLITUDE VALUES FOR A CONSTANT SAMPLING RATE, OF
C     APPROXIMATELY 34 SECONDS.  AVGX IS THE AVERAGE DISTANCE THE RECORD
C     ADVANCES PER ONE HOUR REAL TIME, I.E., THE DATA SAMPLING RATE.  AVGX IS
C     APPROXIMATELY 1.1 INCH PER HOUR.
C     REFERENCE:  CALMA COMPANY MODEL 480 DIGITIZER INSTRUCTION MANUAL.
C     THIS PROGRAM IS DESIGNED TO BE USED ON THE FLEET NUMERICAL WEATHER
C     FACILITY CDC 6500 COMPUTOR AND THE CARDS USED MUST PUNCHED ON CARD PUNCH
C     MACHINES AT FNWF.
C
C
      DIMENSION U(5000),V(5000),N(80),NK(80),IBUFF(3000)
      READ 97,L
   97 FORMAT(I2)
      DO 116 JJ=1,L
      READ 98,AVGX
   98 FORMAT(F10.0)
      READ 50,A,B,C,D
   50 FORMAT(4A10)
      READ 51,E,F,G,H
   51 FORMAT(4A10)
      PRINT 52,A,B,C,D
   52 FORMAT(1H1,39X,4A10)
      PRINT 53,E,F,G,H
   53 FORMAT(1H0,37X,4A10)
      DELT=36.0/AVGX
      PRINT 99,DELT
   99 FORMAT(1H0,2X,25H SAMPLING INTERVAL EQUALS,1X,E15.7,1X,7HSECONDS)
      PRINT 700,JJ
  700 FORMAT(1H0,9HJJ EQUALS,2X,I2)
      DO 100 I=1,5000
      U(I)=0.0
  100 V(I)=0.0
  101 DO 202 I=1,3000
  202 IBUFF(I)=0
      COUNTX=0.0
      COUNTY=0.0
      NUM=3000
      M=1
      K8=0
```

```
      CALL LICF (5LRBCD1,IBUFF,NUM,NPAR,NEOF)
      IF(NEOF) 602,200
  200 K=-7
      KF=0
  201 K=K+8
      KA=K+8
      KC=0
      DO 102 KB=K,KA
      KC=KC+1
      NK(KC)=IBUFF(KB)
  102 IF(NK(KC).EQ.0) KF=1
      DECODE(80,103,NK) (N(I),I=1,80)
  103 FORMAT(80R1)
      DO 104 I9=1,80
      IF(N(I9).EQ.50B) GO TC 106
      IF(N(I9).EQ.55B) GC TO 107
      IF(N(I9).EQ.34B) GC TC 108
      IF(N(I9).EQ.47B) GO TC 105
C
C     SYMBCL /,(50B),REPRENTS AN INCREMENT TRAVEL IN THE MINUS X OR Y DIRECTICN
C     SYMBCL /, (50B), REPRESENTS AN INCREMENT TRAVEL IN THE MINUS X OR Y
C     DIRECTICN BY THE DIGITIZER.
C     SYMBOL 0, (55B), REPRESENTS A ZERO INCREMENT TRAVEL IN THE X OR Y
C     DIRECTION BY THE DIGITIZER.
C     SYMBOL 1, (34B), REPRESENTS AN INCREMENT TRAVEL IN THE POSITIVE X OR Y
C     DIRECTION BY THE DIGITIZER.
C     SYMBOL *, (47B), IS A FLAG INSERTEC IN THE RECORD BY THE PERSCN
C     DIGITIZING.
C
      GO TC 104
  105 PRINT 205,M,I9
  205 FORMAT(1HO,2I10)
      IF(M.GT.10) GC TO 113
      GO TC 104
  106 RX=-0.01
      K8=K8+1
      GO TC 109
  107 RX=0.0
      K8=K8+1
      GO TC 109
  108 RX=0.C1
      K8=K8+1
  109 K3=K8/2
      K3=2*K3
      IF(K3.EQ.K8) GO TO 111
      CCUNTX=CCUNTX+RX
      IF(CCUNTX.EQ.0.07) GO TC 110
      GO TC 104
```

```
110 U(M)=CCUNTX
    GO TC 104
111 COUNTY=CCUNTY+RX
    IF(COUNTX.EQ.0.07) GO TO 112
    GO TC 104
112 V(M)=COUNTY
    COUNTX=0.0
    M=M+1
    IF(M.GT.5000) GC TO 600
104 CONTINUE
    GO TC 201
113 MAX=M-7
C
C   TOTAL TIME OF THE RECCRD EQUALS THE NUMBER OF DATA POINTS TIMES THE
C   SAMPLING INTERVAL, DELT AND MULTIPLIED BY 7.0 BECAUSE THIS PROGRAM IS
C   TAKING EVERY 0.07 INCH INSTEAD OF EVERY 0.01 INCH.
C
    TIME=((M*DELT)/3600.0)*7.0
    PRINT 115,TIME
115 FORMAT(1H ,10X,28H TOTAL TIME OF RECORD EQUALS,2X,E15.7,2X,
   *7H HCURS.)
    PRINT 215,(V(I),I=1,M)
215 FORMAT(1H ,10X,14F7.2)
    PUNCH 213,(V(I),I=1,M)
213 FORMAT(14F5.2)
116 CONTINUE
    STOP
600 PRINT 601
601 FORMAT(1H1,20X,37H***** U AND V SPACE INADEQUATE *****,)
602 STOP
    END
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                       C
C     PROGRAM TIDE                                                      C
C                                                                       C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
C     THIS PROGRAM PROVIDES GRAPH OF TIDAL FLUCTUATIONS.
      DIMENSION TIME(3000),TIDE(3000)
      REAL*8 ITITLE(12)
      REAL LABEL/4H    /
C     NK=NUMBER OF DATA SETS TO BE GRAPHED.
      READ(5,10)NK
      J=1
   13 CONTINUE
      READ(5,105)(ITITLE(I),I=1,12)
  105 FORMAT(6A8)
C     N=NUMBER OF DATA POINTS
C     N MUST BE LESS THAN OR EQUAL TO 144)
      READ(5,10)N
   10 FORMAT(I6)
      DO 1 I=1,N,14
      READ(5,2,END=3)(TIDE(I+K),K=0,13)
    2 FORMAT(14(F5.2))
    1 CONTINUE
    3 CONTINUE
C     MARIGRAM REFERENCE LEVEL OF 13 FEET = 9.8 FT ABOVE MLL WATER.
C     REF. LINEFOR APRIL = 6.5 FT. OR 3.3 FT. ABOVE MLL WATER
C     ADJUST ZERO REF. TO MLL WATER REF.
      WRITE (6,14)
   14 FORMAT (9X,'TIME',7X,'TIDE',5X,'DATA POINT NO.')
      DO 7 I=1,N
      TIDE(I)=TIDE(I)+3.30
    7 CONTINUE
C     SAMPLING INTERVAL = 236.25 SECONDS = 0.0658 HOURS FOR 0.07 INCH
      DO 5 I=1,N
      TIME(1)=0000.
      TIME(I+1) = I*0.0658
    4 CONTINUE
      WRITE(6,6)TIME(I),TIDE(I),I
    6 FORMAT(5X,F10.4,5X,F6.2,5X,I6)
      IF (I.LE.720) GO TO 5
C     SET SCALES FOR GRAPHICAL DISPLAY
      TIDE (I) = TIDE (I) + 8.0
      TIME (I) = TIME (I) - 45.
    5 CONTINUE
C     INVERT GRAPHICAL DISPLAY.
      DO 19 I=1,N
```

```
      TIDE(I)=-TIDE(I)
   19 CONTINUE
      IF (N.LE.720) GO TO 72
      M=720
      GO TO 73
   72 CONTINUE
      M=N
   73 CONTINUE
      CALL DRAW ( M ,TIDE(    1),TIME(    1),1,0,LABEL,ITITLE,2.,3.,0,8,
     ,2,2,9,15,1,LAST)
      IF (N.LE.720) GO TO 720
      M=N-720
      CALL DRAW ( M ,TIDE( 721),TIME( 721),3,0,LABEL,ITITLE,2.,3.,0,8,
     ,2,2,9,15,1,LAST)
  720 CONTINUE
      J=J+1
      IF (J.LE.NK)GO TO 13
      STOP
      END
//GO.FT06F001  DD  SPACE=(CYL,(30,1))
//GO.SYSIN DD *
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                               C
C     PROGRAM CURRENT                                                           C
C                                                                               C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
C         THIS PROGRAM PROVIDES ELEMENTARY STATISTICS FOR THREE TIME
C     SERIES OF CURRENT TEMPERATURE, SPEED, AND DIRECTION.  MEANS ARE
C     COMPUTED HOURLY, DAILY AND FOR THE ENTIRE SERIES.  A HISTOGRAM
C     IS PROVIDED DAILY AND FOR THE SERIES.  VARIANCE AND STANDARD
C     DEVIATION ARE COMPUTED FOR THE SERIES.  OPTIONAL GRAPHICAL OUTPUTS
C     HISTOGRAMS ARE PROVIDED.
C
C
      DIMENSION DATE(3),DATO(3),TIME(3000),T(3000),S(3000),D(3000),
     1M(3000)
      REAL LABEL/4H    /
C     IND=NUMBER OF DATA SETS
      IND=1
      DO 1313 III=1,IND
      CLOCK=ITIME(0)*0.01
C     CONTROL CARD INPUT:
      READ(5,202)NN,NO,NT,NA,NH,NP,PN,NW,PW,ICOR,IMO,DATE,DATO
C       NN=NO. OF DATA POINTS; CALL DRAW MUST BE ADJUSTED
C          TO TOTAL OF NN POINTS(I4)
C       NO=DAY OF FIRST OBSERVATION(I2)
C       NT=TIME OF FIRST OBSERVATION(I4)
C       NA=LARGEST NT LESS THAN 2400(I4)
C       NH=HOUR FRACTION(IN MIN.) OF FIRST OBS. (I2)
C       NP=LATITUDE DEGREES(I2)
C       PN=LATITUDE MINUTES (F6.2)
C       NW=LONGTITUDE DEGREES(I3)
C       PW=LONGTITUDE MINUTES(F6.2)
C       ICOR=DIRECTION CORR. FOR MAGNETIC VAR. OR DEV. (I3)
C       IMO=LAST DAY OF MONTH(I3)
C       DATE=MONTH OF OBSERVATION(3A4)
C       DATO=DATE PLUS ONE MONTH(3A4)
      DEL=3.75
C     DEL IS THE SAMPLING INTERVAL IN MINUTES
      TIME(1)=0.
      NODRW=0
C     NODRW=1 IF GRAPHS ARE NOT DESIRED
      L=0
      NZ=0
      IDAY=1
      WRITE(6,104)NP,PN,NW,PW,NO,NT,DATE
      WRITE(6,100)
```

```
      WRITE(6,106)NC,NT,DATE
C     INPUT TEMP, SPEED, AND DIRECTION TIME SERIES
      DO 5 I=1,NN,5
      READ(5,200,END=55)(T(I+K),S(I+K),M(I+K),K=0,4)
    5 CONTINUE
   55 CONTINUE
C     ADJUST DIRECTION IF REQUIRED
   41 DO 10 I=1,NN
      M(I)=M(I)+ICOR
      IF(M(I)-0.)42,43,43
   42 M(I)=M(I)+360
   43 CONTINUE
      N=I
      IF(T(I).EQ.1.)GO TO 10
    7 WRITE(6,101)TIME(I),T(I),S(I),M(I),I
      IF(L.LT.16)GO TO 8
      NT=NT+100
      IF(NT.LE.NA)GO TO 56
      NT=0000+NH
      NO=NO+1
      IMN=I-NZ
C     AT END OF EACH DAY COMPUTE STATISTICS
      CALL DAY(T,S,M,IMN,I,1,DTAV,DSAV,DDAV)
      IDDAV=IFIX(DDAV)
      WRITE(6,88)IDAY,DTAV,DSAV,IDDAV
   88 FORMAT(5X,'DAY ',I2,' STATISTICS:     AVGDAYTEMP=',F6.2,3X,
     1'AVGDAYSPD=',F5.2,3X,'AVGDAYDIR=',I4,//)
      IDAY=IDAY+1
   87 CONTINUE
      NZ=0
C     IF MONTH CHANGES REPLACE THE DATE
   56 IF(NO.LE.IMO)GO TO 3
      NO=1
      DO 60 J=1,3
   60 DATE(J)=DATO(J)
    3 CONTINUE
      HR = TIME (I)/60.
      IF(I.GE.18)GO TO 11
      IML=I-L
      GO TO 12
   11 CONTINUE
      IML=I-L+1
   12 CONTINUE
C     CALL SUBROUTINES FOR HOURLY MEANS
      CALL MEAN(T,IML,I,AT )
      CALL MEAN(S,IML,I,AS )
      CALL MEAND(M,IML,I,S,AVG)
      MD=IFIX(AVG)
```

```
      IF(MD.GE.0)GO TO 58
      MD=360+MD
   58 CONTINUE
C     WRITE OUT THE HOURLY MEANS
      WRITE (6,103) NC,NT,DATE,HR,AT,AS,MD
      L=0
    8 TIME(I+1)=TIME(I)+DEL
      NZ=NZ+1
      L=L+1
   10 CONTINUE
      N=NN
C     COMPUTE THE TIME SERIES MEANS
      CALL MEAN(T,1,N,TAT)
      CALL MEAN(S,1,N,TAS)
      CALL MEAND(M,1,N,S,AVG)
      MMD=IFIX(AVG)
      IF(MMD.GE.0)GO TO 57
      MMD=360+MMD
   57 CONTINUE
      WRITE(6,107)TAT,TAS,MMD
      DO 16 I=1,N
   15 D(I)=FLOAT(M(I))
   16 CONTINUE
C     CALL HISTO SUBROUTINE FOR TIME SERIES HISTOGRAM
      CALL HISTO(5.,16.,44,T,NN,1,NODRW)
      CALL HISTO(0.,1.,20,S,NN,1,NODRW)
      CALL HISTO(0.,360.,36,D,NN,1,NODRW)
C     CALL POWER SUBROUTINE FOR RMS,VARIANCE, AND STANDARD DEVIATIONS
      CALL POWER (DEL,NN,T,S,D,100)
      CLOCK=ITIME(0)*0.01-CLOCK
      WRITE(6,999)CLOCK
  105 FORMAT(6A8)
  202 FORMAT(I4,I2,2I4,2I2,F6.2,I3,F6.2,2I3,3A4,3A4)
  104 FORMAT(1H1,T40,'CURRENT DATA OBTAINED IN MONTEREY CANYON',///,5X,
     5'METER POSITION:  ',
     1I2,F6.2,' N   ',I3,F6.2,' W',/,5X,'ZERO TIME: ',I2,I4,'(LOCAL)',
     2 3A4,//,5X,'TIME IN MINUTES',/,5X,'TEMPERATURE IN DEGREES CENTIGRA
     3DE',/,5X,'CURRENT SPEED IN KNOTS ',/,5X,'CURRENT DIRECTION IN DEGR
     4EES TRUE',////)
  100 FORMAT(15X,'TIME',10X,'TEMPERATURE',6X,'CURRENT SPEED',
     14X,'CURRENT DIRECTION')
  106 FORMAT(1H0,5X,I2,I4,3A4)
  200 FORMAT(5(F5.1,F5.2,I4))
  101 FORMAT(     10X,F10.2,13X,F4.1,15X,F5.2,14X,I3,5X,I5)
  103 FORMAT(1H0,I3,I4,3A4,2X,F5.1,'HRS',4X,'MEAN TEMP:',
     1F6.2,4X,'MEAN SPEED:',F5.2,2X,'MEAN DIR:',I3,//)
  107 FORMAT(1H0,11X,'MEANS FOR THIS RECORD:   TEMP:',F6.2,2X,'SPEED:',
     1F5.2,2X,'DIRECTION:',I3)
```

```
  999 FORMAT(///,T80,'ELAPSED COMPUTING TIME=',F15.7,'SECONDS')
 1313 CONTINUE
      STOP
      END



      SUBROUTINE MEAN(A,J,M,AVG)
C     THIS SUBROUTINE COMPUTES THE ARITHMETIC MEAN OF
C     ANY INPUT PARAMETER.
      DIMENSION A(3000)
      AVG=0.0
      SUM=0.0
      KK=M-J+1
      FKK=FLOAT(KK)
      DO 1 K=J,M
    1 SUM=SUM+A(K)
      AVG=SUM/FKK
      RETURN
      END



      SUBROUTINE MEAND(LL,J,M,S,AVG)
C     THIS SUBROUTINE COMPUTES THE MEANS OF DIRECTIONS INPUT AS
C     COMPASS HEADINGS BY SUMMING SINES AND COSINES, CONVERT
C     TO VECTOR WITH SPEED, THEN NORMALIZE AND FIND THE
C     ARCTANGENT.  THIS PROCEDURE NECESSARY TO CIRCUMVENT THE
C     000 TO 360 DISCONTINUITY.
      DIMENSION LL(3000),S(3000)
      SUM1=0.0
      SUM2=0.0
      DO 1 K=J,M
      AK=LL(K)*0.01745329
      IML=M-J+1
      IF (S(K).GT.0.0) GO TO 13
C     SPEED NOT AVAILABLE. READ FROM DATA CARDS AS S(K)=0.0          I ONLY
C     INSERT FALSE VALUE TO ELIMINATE DIVISION BY ZERO.              I ONLY
      S(K)=0.001
   13 CONTINUE
      SUM1=SUM1+S(K)*SIN(AK)
      SUM2=SUM2+S(K)*COS(AK)
    1 CONTINUE
      U=SUM1/FLOAT(IML)
      V=SUM2/FLOAT(IML)
      USQ=U**2
```

```
      VSQ=V**2
      SUMSQ=USQ+VSQ
      VAVG=SQRT(SUMSQ)
      X=U/V
      AVG=ATAN2(U,V)
      AVG=AVG/.01745329
      RETURN
      END



      SUBROUTINE HISTO(A,Z,K,X,L,M,NODRW)
C     THIS SUBROUTINE OBTAINS HISTOGRAM, PERCENT OF DATA PER
C     INTERVAL, PROBABILITY DENSITY, AND PROBABILITY DISTRIBUTION.
C     ENTER WITH: A=LOWER BOUND
C                 Z=UPPER BOUND
C                 K=NO.INTERVALS(MAX=50)
C                 X=VARIABLE NAME
C                 L=NO.VARIABLES(MAX=3000)
C                 NODRW=1 (IF GRAPH NOT DESIRED)
      DIMENSION N(3000),X(3000),P(55),PP(55),D(55),PD(55),B(3000)
      REAL*8 ITITLA(12)
      REAL LABEL/4H    /
      IF(NODRW.EQ.1)GO TO 12
      READ(5,105)(ITITLA(I),I=1,12)
   12 CONTINUE
      WRITE(6,101)
      LL=0
      C=(Z-A)/FLOAT(K)
      D(1)=A
      KP1=K+1
      KP2=K+2
      DO 1 I=2,KP2
      IM1=I-1
    1 D(I)=A+IM1*C
      SUMP=0.0
      DO 5 I=1,KP2
    5 B(I)=0
      LLL=M+L
      DO 2 J=M,LLL
      DO 3 I=1,KP2
      IP1=I+1
      IF(X(J).LT.D(I))GO TO 3
      IF(X(J).GE.D(I))GO TO 4
    4 IF(X(J).LT.D(IP1))GO TO 10
      GO TO 3
   10 B(I)=B(I)+1.
```

```
      LL=LL+1
      IF(X(J).LE.Z)GO TO 3
      LL=LL-1
    3 CONTINUE
    2 CONTINUE
      DO 6 I=1,KP2
    6 P(I)=B(I)/FLOAT(LL)
      DO 7 I=1,KP2
    7 PP(I)=P(I)/C
      DO 8 I=1,KP2
      SUMP=SUMP+PP(I)
    8 PD(I)=SUMP*C
      DO 9 I=1,KP1
      IP1=I+1
      N(I)=IFIX(B(I))
      WRITE(6,100)I,D(I),D(IP1),N(I),P(I),PP(I),PD(I)
    9 CONTINUE
  101 FORMAT(1H0,10X,'INTERVAL',11X,'OCCURRENCES',3X,'% DATA',3X,
     1'DENSITY',3X,'DISTRIBUTION',//)
  100 FORMAT(4X,I2,F7.2,' - ',F7.2,4X,I3,3F12.3)
      WRITE(6,103)LL
  103 FORMAT(//,8X,'NUMBER OF POINTS :    ',I8)
  105 FORMAT(6A8)
      DO 11 I=1,KP1
   11 D(I)=D(I)+(C/2.)
      IF(NODRW.EQ.1)RETURN
      CALL DRAW(KP1,D,B,0,0,LABEL,ITITLA,0,0,0,0,0,0,3,5,0,LAST)
      RETURN
      END


      SUBROUTINE POWER (DEL,N,X,Y,Z,L)
C     THIS SUBROUTINE COMPUTES MEANS, MEAN SQUARED VALUES AND
C     STANDARD DEVIATIONS OF THREE INPUT TIME SERIES.
      DIMENSION XM(3000),X(3000),Y(3000),Z(3000)
C  ENTER WITH:      DEL=SAMPLING INTERVAL IN MINUTES
C                   N=NUMBER OF SAMPLES (MAX.=3000)
C                   X=VARIABLE OF THE FIRST SERIES
C                   Y=VARIABLE OF THE SECOND SERIES
C                   Z=VARIABLE OF THE THIRD SERIES
C                   L=NUMBER OF LAGS (MAX.=200)
C     CALCULATION OF SERIES MEAN VALUE
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      DO 2 I=1,N
```

```
      SUM1=SUM1+X(I)
      SUM2=SUM2+Y(I)
    2 SUM3=SUM3+Z(I)
      XBAR=SUM1/N
      YBAR=SUM2/N
      ZBAR=SUM3/N
      WRITE(6,3)XBAR,YBAR,ZBAR
    3 FORMAT(T10,'SAMPLE MEANS:',//T35,'XBAR= ',F10.3,/,T35,'YBAR= ',
     1F10.3,/,T35,'ZBAR= ',F10.3,///)
C     TRANSFORMATION TO ZERO MEAN VALUE
      DO 4 I=1,N
      XM(I)=X(I)-XBAR
    4 CONTINUE
      CALL MEAN (XM,1,N,AVG)
      WRITE (6,15)AVG
      DO 44 I=1,N
      XM(I)=Y(I)-YBAR
   44 CONTINUE
      CALL MEAN (XM,1,N,AVG)
      WRITE (6,15)AVG
      DO 444 I=1,N
      XM(I)=Z(I)-ZBAR
  444 CONTINUE
      CALL MEAN (XM,1,N,AVG)
      WRITE (6,15)AVG
   15 FORMAT(T40,F30.10)
C     CALCULATION OF THE MEAN SQUARE VALUE
      SUM1=0.0
      SUM2=0.0
      SUM3=0.0
      DO 5 I=1,N
      SUM1=SUM1+(X(I)-XBAR)**2
      SUM2=SUM2+(Y(I)-YBAR)**2
      SUM3=SUM3+(Z(I)-ZBAR)**2
    5 CONTINUE
      XMS=SUM1/N
      YMS=SUM2/N
      ZMS=SUM3/N
      WRITE(6,6)XMS,YMS,ZMS
    6 FORMAT(T10,'MEAN SQUARE VALUES:',//,T35,'XMSQ= ',F10.3,/,T35,
     1'YMSQ= ',F10.3,/,T35,'ZMSQ= ',F10.3,///)
C     CALCULATION OF THE STANDARD DEVIATION
      XTEMP=SUM1/(N-1)
      YTEMP=SUM2/(N-1)
      ZTEMP=SUM3/(N-1)
      SX=SQRT(XTEMP)
      YX=SQRT(YTEMP)
      ZX=SQRT(ZTEMP)
```

```
      WRITE(6,7)SX,YX,ZX
    7 FORMAT(T10,'STANDARD DEVIATIONS:',//,T35,'XSTDDEV= ',F10.5,/,T35,
     1'YSTDDEV= ',F10.5,/,T35,'ZSTDDEV= ',F10.5,///)
      RETURN
      END



      SUBROUTINE DAY(T,S,M,J,K,NODRW,DTAV,DSAV,DDAV)
C     THIS SUBROUTINE UTILIZES PREVIOUS SUBROUTINES TO OBTAIN
C     DAILY STATISTICS.
      DIMENSION DH(3000),T(3000),S(3000),M(3000)
C     ENTER WITH:  T=TEMPERATURE SERIES
C                  S=SPEED SERIES
C                  M=DIRECTION SERIES
C                  J=DAY START OBSERVATION NUMBER
C                  K=TOTAL OBSERVATIONS IN THE SERIES
C                  NODRW=1  (IF GRAPH NOT DESIRED)
      CALL MEAN(T,J,K,DTAV)
      CALL MEAN(S,J,K,DSAV)
      CALL MEAND(M,J,K,S,DDAV)
      IF(DDAV.GE.0)GO TO 2
      DDAV=DDAV+360.
    2 CONTINUE
      JP1=J+1
      KK=K-JP1
      WRITE(6,3)JP1,K,KK
    3 FORMAT(2X,'DAILY HISTO FROM',I4,' TO ',I4,' TOTAL: ',I4,'PTS',//)
      DO 1 I=JP1,K
    1 DH(I)=FLOAT(M(I))
      CALL HISTO(5.,16.,44,T ,KK,J,NODRW)
      CALL HISTO(0.,1.,20,S ,KK,J,NODRW)
      CALL HISTO(0.,360.,36,DH,KK,J,NODRW)
      RETURN
      END
//GO.FT06F001 DD SPACE=(CYL,5)
//GO.SYSIN DD *
```

APPENDIX I

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                C
C      PROGRAM COMPCSITE DRAW                                    C
C                                                                C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
C      THIS PROGRAM  PROVIDES FOR A COMBINED TEMPERATURE, CURRENT SPEED,
C      AND DIRECTION GRAPH
       DIMENSION T(800),TIME(800),S(800),M(800),A(800),B(800),C(800)
       REAL*8 ITITLE (12)
       REAL LABEL /4H    /
C      ND=NUMBER OF DATA SETS
       READ(5,20)ND
       WRITE (6,22)ND
   22  FORMAT (//,5X,I4,'  DATA SETS')
       DO 999 J=1,ND
       WRITE (6,8)J
    8  FORMAT(//,5X,'DATA SET NUMBER',I4)
C      PROVIDE GRAPH TITLE.  TITLE IS 2 CARDS WITH NO MORE THEAN 48
C      CHARACTERS EACH (6A8)
       READ (5,105)(ITITLE(I),I=1,12)
  105  FORMAT (6A8)
C      NN=NUMBER OF DATA POINTS
C      NN MUST NOT EXCEED 720
       READ(5,20)NN
   20  FORMAT(I6)
       WRITE (6,1) NN                                                ***
    1  FORMAT (//,5X,'NN=',I4)                                       ***
C      DEL IS THE SMAPLING INTERVAL IN HOURS (3.75 MIN.= .0625 HOURS)
       DEL=0.0625
       WRITE (6,2) DEL                                               ***
    2  FORMAT (5X,'DEL=',F7.4)
       TIME(1)=0
       NODRW=0
       WRITE (6,4) NODRW                                             ***
    4  FORMAT (5X,'NODRW=',I4)                                       ***
       DO 5 I=1,NN,5
       READ (5,200)(T(I+K),S(I+K),M(I+K),K=0,4)
  200  FORMAT(5(F5.1,F5.2,I4))
    5  CONTINUE
       WRITE (6,6)                                                   ***
    6  FORMAT (//,5X,'DATA INPUT COMPLETED')                         ***
C      SET SCALES FOR GRAPHICAL DISPLAY
       DO 10 I=1,NN
       TIME(I+1)=I*DEL
       C(I)= -(T(I)/2.0)-15.0
       A(I)=(FLOAT(M(I))/24.)
```

```
      B(I)=-(S(I)*15.)
   10 CONTINUE
      WRITE (6,7)
    7 FORMAT (//,5X,'DATA CONVERTED FOR GRAPHICAL DISPLAY')                    ***
      CALL DRAW (NN,C,TIME,1,0,LABEL,ITITLE,5.,6.,0,6,2,2,9,9,0,LAST)          ***
      CALL DRAW (NN,B,TIME,2,0,LABEL,ITITLE,5.,6.,0,6,2,2,9,9,0,LAST)
      CALL DRAW (NN,A,TIME,3,0,LABEL,ITITLE,5.,6.,0,6,2,2,9,9,0,LAST)
  999 CONTINUE
      RETURN
      END
//GO.SYSIN DD *
```

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                        C
C     PROGRAM TEMPERATURE DRAW                                           C
C                                                                        C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C
C     THIS PROGRAM PROVIDES A TEMPERATURE  GRAPH.   THE PROGRAM IS BASICALLY THE
C     SAME AS PROGRAM COMPOSITE DRAW; HOWEVER, THIS PROGRAM DRAWS TEMPERATURE TO
C     AN EXPANDED SCALE.
C
C
      DIMENSION T(800),TIME(800),S(800),M(800),A(800),B(800),C(800)
      REAL*8 ITITLE (12)
      REAL LABEL /4H    /
C     ND=NUMBER OF DATA SETS
      READ(5,20)ND
      WRITE (6,22)ND
   22 FORMAT (//,5X,I4,'  DATA SETS')
      DO 999 J=1,ND
      WRITE (6,8)J
    8 FORMAT(//,5X,'DATA SET NUMBER',I4)
C     PROVIDE GRAPH TITLE.  TITLE IS 2 CARDS WITH NO MORE THEAN 48
C     CHARACTERS EACH (6A8)
      READ (5,105)(ITITLE(I),I=1,12)
  105 FORMAT (6A8)
C     NN=NUMBER OF CATA POINTS
C     NN MUST NOT EXCEED 720
      READ(5,20)NN
   20 FORMAT(I6)
      WRITE (6,1) NN                                                   ***
    1 FORMAT (//,5X,'NN=',I4)                                          ***
C     DEL IS THE SMAPLING INTERVAL IN HOURS (3.75 MIN.= .0625 HOURS)
      DEL=0.0625
      WRITE (6,2) DEL                                                  ***
    2 FORMAT (5X,'DEL=',F7.4)
      TIME(1)=0
      NODRW=0
      WRITE (6,4) NODRW                                                ***
    4 FORMAT (5X,'NODRW=',I4)                                          ***
      DO 5 I=1,NN,5
      READ (5,200)(T(I+K),S(I+K),M(I+K),K=0,4)
  200 FORMAT(5(F5.1,F5.2,I4))
    5 CONTINUE
      WRITE (6,6)                                                      ***
    6 FORMAT (//,5X,'DATA INPUT COMPLETED')                            ***
C     SET SCALES FOR GRAPHICAL DISPLAY
      DO 10 I=1,NN
```

```
      TIME(I+1)=I*DEL
      C(I) = T(I)
      A(I)=(FLOAT(M(I))/24.)
      B(I)=-(S(I)*15.)
   10 CONTINUE
      WRITE (6,7)                                                              ***
    7 FORMAT (//,5X,'DATA CONVERTED FOR GRAPHICAL DISPLAY')                    ***
      CALL DRAW (NN,TIME,C,0,0,LABEL,ITITLE,6.,1.,0,0,2,2,9,8,0,LAST)
C     CALL DRAW STATEMENTS FOR SPEED, B, AND DIRECTION, A, HAVE BEEN DELETED IN
C     ORDER TO DRAW ONLY TEMPERATURE TO AN EXPANDED SCALE
  999 CONTINUE
      RETURN
      END
//GO.SYSIN DD *
```

APPENDIX K

```
C
C FOURIER TRANSFORM OF TIME SERIES DATA SUPPLIED THROUGH
C 'OCEAN' SUBROUTINES USING P-K FORT FAST FOURIER TRANSFORM
C SUBROUTINE (SHARE SDA3465) IN THE IBM SYSTEM 360 MODEL 67.
C
C LAST REVISION JANUARY 24,1969            JOHN GARRETT
C
C   NBLOCK BLOCKS OF 2**NPOW SAMPLES EACH ARE READ FOR KCHAN OF THE
C NCHAN CHANNELS AVAILABLE TO THE 'OCEAN' SUBROUTINES.  THE CONTENTS OF
C ANY CHANNEL MAY BE REPLACED BY A LINEAR COMBINATION OF ITSELF WITH ANY
C OTHER CHANNEL.
C
C  FOR EACH BLOCK 2**(NPOW-1) COMPLEX FOURIER COEFFICIENTS ARE
C COMPUTED FOR EACH OF THE KCHAN CHANNELS.  THESE ARE THEN WRITTEN ON THE
C OUTPUT (TAPE) 03 IN THE FORMAT DESCRIBED BELOW. IN ADDITION THE
C COEFFICIENTS MAY BE SUMMED IN GROUPS OF (2**(NPOW-1))/32 AND
C PRINTED OUT.
C
C  ADDITIONAL OPTIONS ARE DESCRIBED UNDER THE RELEVANT CONTROL
C PARAMETERS BELOW.
C
C     IT SHOULD BE NOTED THAT THE COEFFICIENTS PRODUCED ARE THOSE OF THE
C FOURIER SERIES
C     Y(J) = SUM OVER K = 0,N/2 OF REAL PARTS OF
C               (C(K)*EXP((2*PI*I/N)*J*K))
C     WITH J = 0,N-1,Y(J)REAL,AND I = SQRT(-1)
C
C THE FOLLOWING SUBROUTINES ARE REQUIRED
C      OCEAN1,OCEAN2,OCEAN3,RWUNLD
C      SKPFL
C      CONVCL
C      USCRMB
C      P-K FORT
C
C THE FOLLOWING LOGICAL INPUT/OUTPUT DEVICES ARE USED IN THIS PROGRAM
C      2 = SCRATCH TAPE FOR TEMPORARY STORAGE OF COEFFICIENTS IF
C          LOFR=1 BELOW
C      3 = OUTPUT (TAPE) FOR COEFFICIENTS
C      5 = (CARD) INPUT FOR CONTROL PARAMETERS
C      6 = PRINTED OUTPUT
C      INUNIT = INPUT TAPE OF TIME SERIES DATA FOR 'OCEAN' SUBROUTINES
C
C INPUT INFORMATION REQUIRED
C     FIRST DATA CARD IN COLUMN NUMBER
C     1-9   IDUSER = USER IDENTIFICATION NUMBER (9-DIGIT INTEGER)
C     14-15 NCHAN = NUMBER OF CHANNELS DIGITIZED ON OCEAN TAPE
C     25    NTYPE = (NOT RELEVENT. SET TO ZERO.)
C     34-35 INFILE = FILE NUMBER OF DATA ON OCEAN TAPE
```

```
C      44-45 INUNIT = NUMBER OF UNIT ON WHICH INPUT TAPE IS MOUNTED
C      55    NSEARH = (NOT RELEVENT. SET TO ZERO.)
C      61-70 SAMFRQ = SAMPLING FREQUENCY OF DIGITIZING  (SAMPLES/SECOND)
C                     (MUST  INCLUDE  A DECIMAL POINT )
C      SECOND DATA CARD
C      4-5   NBLOCK = NUMBER OF BLOCKS DESIRED
C      14-15 NPOW- MAXIMUM NUMBERS OF SAMPLES PER BLOCK WILL BE 2**NPOW,
C               MAX NPOW IS 13 (8192 SAMPLES/BLOCK) BUT NPOW WILL BE
C               REDUCED UNTIL (2**NPOW)*KCHAN WILL FIT IN MEMORY. FOR
C               KCHAN OF 10 THIS WILL GIVE NPOW = 10 (1024 SAMPLES/BLOCK).
C      24-25 MTAPE =+1 FOR OUTPUT TAPE TO BE WRITTEN
C                  =-1 FOR NO OUTPUT TAPE
C      34-35 NFILE - OUTPUT COEFFICIENTS WILL BE NFILE-TH FILE ON TAPE
C      43-45 MAXERR = (NOT RELEVENT. SET TO ZERO.)
C      54-55 MPRINT = -1 SUPPRESSES SUMMARY COEFFICIENTS PRINT OUT
C                   = 0 OR GREATER PERMITS PRINT OUT
C      THIRD DATA CARD
C      4-5   KCHAN = NUMBER OF CHANNELS TO BE TRANSFORMED (MAX 10)
C      15    LOFR = 2 IF COEFFICIENTS TO BE COMPUTED FROM DATA SMOOTHED
C                   AND SUBSAMPLED (DECIMATED) USING CONVOL SUBROUTINE.
C                   WEIGHTS USED IN SMOOTHING AND DECIMATING FACTOR ARE
C                   DETERMINED BY CHOICE OF CONVOL USED.
C               = 1 IF ALTERNATE BLOCKS TO BE MADE UP OF SAMPLES FROM DATA
C                   SMOOTHED AND DECIMATED USING CONVOL SUBROUTINE.
C                   COEFFICIENTS WILL APPEAR ON OUTPUT TAPE IN FILE
C                   IMMEDIATELY FOLLOWING THAT CONTAINING RESULTS FROM
C                   UNSMOOTHED DATA
C                   = 0 IF DATA TO BE LEFT ALONE
C      25    IHANN = 1 IF FOURIER COEFFICIENTS TO BE HANNED AND
C                    NORMALIZED (*SQRT(8/3))
C                  = 0 IF NOT
C
C      NEXT KCHAN CARDS
C      1-5   NO. OF PRIMARY A TO D CHANNEL
C      6-10  NO. OF SECONDARY A TO D CHANNEL
C      11-20 CALIBRATION ASSOCIATED WITH THE PRIMARY A TO D CHANNEL
C      21-30 CALIBRATION ASSOCIATED WITH THE SECONDARY A TO D CHANNEL
C      31-66 ALPHAMERIC NAME OF RESULTING PRIMARY CHANNEL
C      71-78 8 CHARACTER NAME OF UNITS FOR RESULTING PRIMARY CHANNEL
C
C THE DATA TRANSFORMED AS THE PRIMARY CHANNEL IS THEN
C
C      CALIBRATION1 X VALUE OF PRIMARY + CALIBRATION2 X VALUE OF
C      SECONDARY CHANNEL
C
C
C A SECOND SET OF DATA CARDS WILL PRODUCE A SECOND ANALYSIS. A BLANK
C CARD TERMINATES THE RUN.
```

```
C
C FORMAT OF OUTPUT TAPE FOR EACH BLOCK TRANSFORMED IS AS FOLLOWS
C     FIRST LOGICAL RECORD IS AN ARRAY OF 256 WORDS CALLED
C     ARTAPE(4) = NTAP (SEE BELOW)
C     ARTAPE(1)= IDUSER
C    ARTAPE
C     ARTAPE(3) = NUMBER OF SAMPLES /BLOCK
C     ARTAPE(2)= BLOCK NUMBER
C     ARTAPE(10) = IHANN
C     ARTAPE(5) = NUMBER 6F CHANNELS TRANSFORMED
C     ARTAPE(6) = SAMPLING FREQUENCY
C     ARTAPE(10+K) = MCHAN(K)
C     ARTAPE(31+9(K-1)) = ACHNAM(K)     (9A4)
C     ARTAPE(121+2(K-1)) = AUNITS(1,K)    (2A4)
C     ARTAPE(140+K) = CAL(K)
C
C     NEXT NTAP LOGICAL RECORDS OF 256 WORDS EACH CALLED
C    TAPRAY AND CONSIST OF
C     1 WORD CONTAINING INTEGER HARMONIC NO (0 TO IBLOCK/2) FOLLOWED BY
C     2*KCHAN WORDS CONTAINING FOR EACH OF THE KCHAN CHANNELS THE
C       REAL PART OF THE FOURIER COEFF  AT THIS HARMONIC(FIRST WORD)
C       FOLLOWED BY THE IMAGINARY PART(SECOND WORD).
C     ONLY COMPLETE SEQUENCES OF 1+(2*KCHAN) WORDS ARE INCLUDED IN A
C     TAPRAY SO THAT THE LAST FEW WORDS MAY CONTAIN ZEROS
C
C AN END OF FILE IS WRITTEN ON THE OUTPUT TAPE AT THE END OF A SEQUENCE
C     OF BLOCKS
C
C  J.F. GARRETT                        INSTITUTE OF OCEANOGRAPHY
C  J.R. WILSON                         UNIVERSITY OF BRITISH COLUMBIA
C                                      VANCOUVER 8,CANADA
C
      DIMENSION W(10242),S(4100),ARTAPE(256),TAPRAY(256),MCHAN(10),
     1CAL(10),AUNITS(2,10),ACHNAM(9,10),INDCH(12),I2TAB(14),INCR(10),
     2INDATA(12),W1(1024),W2(1024),W3(1024),W4(1024),W5(1024),
     3W6(1024),W7(1024),W8(1024),W9(1024),W10(1024),A(256) ,ATA(12)
     4 , VAL(50,10)
      DIMENSION MCHAN2(10),CAL2(10),DDFREQ(20)
      COMMON W,S,NAN,KOUNT
      EQUIVALENCE (W(1),W1(1)),(W(1025),W2(1)),(W(2049),W3(1)),
     1 (W(3073),W4(1)),(W(4097),W5(1)),(W(5121),W6(1)),(W(6145),W7(1)),
     2 (W(7169),W8(1)),(W(8193),W9(1)),(W(9217),W10(1)),(ARTAPE(1),A(1))
     3,(A(1),IDUSER),(A(2),MBLOCK),(A(3),IBLOCK),(A(4),NTAP),
     4 (A(5),KCHAN),(A(6),SAMFRQ),(A(11),MCHAN(1)),
     5 (A(31),ACHNAM(1,1)),(A(121),AUNITS(1,1)),(A(141),CAL(1)),
     6 (A(151),INDCH(1)),(A(163),I2TAB(1)),(A(180),INCR(1)),
     7 (A(190),INDATA(1)),(A(210),TAPRAY(1)),(A(210),IAR),
     8 (A(190),ATA(1))
```

```
      NZBLOK = 0
      CORNB = 1./SQRT(6.0)
      CORNA = 2.0 * CORNB
      IOFPOS = 0
 6000 READ (5,5,END=6010) IDUSER,NCHAN,NTYPE,INFILE,INUNIT,NSEARH,SAMFRQ
      IF (INFILE.EQ.0) GO TO 6010
      DFREQ = SAMFRQ
      DO 10010 I=1,10
      MCHAN(I) = 0
      MCHAN2(I)=0
      CAL(I)=0.
      CAL2(I)=0.
      DO 10009 J=1,9
10009 ACHNAM(J,I) = 0
      DO 10010 J=1,2
      AUNITS(J,I) = 0
10010 CONTINUE
      DO 10012 I=1,12
10012 INDCH(I) = 0
      READ (5,6) NBLOCK,NPOW,MTAPE,KFILE,MAXERR,MPRINT,IRWCTL
      IF (IOFPOS.EQ.0) NFILE = KFILE
      READ(5,6) KCHAN ,LOFR,IHANN
      ARTAPE(10) = IHANN
      IF (LOFR.EQ.1) REWIND 2
      DO 8 K = 1,KCHAN
      READ (5,7) MCHAN(K),MCHAN2(K),CAL(K),CAL2(K),(ACHNAM(L,K),L=1,9),
     1(AUNITS(L,K),L=1,2)
      IF (MCHAN2(K).EQ.0) MCHAN2(K) = 1
      IF (MCHAN(K).EQ.0) GO TO 9
      KCH = MCHAN(K)
      INDCH(KCH) = K
8     KCH = K
9     KCHAN = KCH
C SET UP TWOS TABLE
      DO 10 N =1,14
10    I2TAB(N) = 2**N
C DETERMINE BLOCK SIZE
11    LOKTES = KCHAN*I2TAB(NPOW)
      IF(LOKTES.LE.10242) GO TO 15
      NPOW = NPOW-1
      GO TO 11
15    IBLOCK = I2TAB(NPOW)
      KBLOCK = IBLOCK/2
      KCH = 256/(1+(2*KCHAN))
      NTAP =(KBLOCK + KCH -1)/KCH
C COMPUTE SINE TABLE
      CALL FORT(W,NPOW,S,0,IFERR)
C POSITION OUTPUT TAPE
```

```
      IF (MTAPE.LT.0) GO TO 31
      IF (IOFPOS.NE.0) GO TO 31
      REWIND 3
      IOFPOS = 1
      IF (KFILE.GT.1) CALL SKPFL (KFILE-1,3)
C SET UP INPUT TAPE
   31 CALL OCEAN1 (NCHAN,INUNIT,MAXERR,INFILE,NTYPE,NSEARH)
      WRITE(6,35) IDUSER,NCHAN,KCHAN,NBLOCK,IBLOCK,SAMFRQ
      IF(IHANN.GT.0) WRITE(6,36)
      IF(LOFR.GT.0) CALL CONVOL(VAL,MXWAY,LDEC,1,SUM)
      DECIM = LDEC
      LINCR = IBLOCK
      IF(IBLOCK.LT.1024) LINCR = 1024
C SET UP STORAGE REFERENCES
      DO 40 K = 1,KCHAN
      KCH = K -1
40    INCR(K) = LINCR *KCH
      MINCR = LINCR
      LOBLO = LOFR
      MBLOCK = 1
C READ SOME DATA
12    NPAR = 0
      IADD = 0
      N111 = 0
 7000 NOLD = 1
      SAMFRQ = DFREQ
      IF(LOBLO.GT.0) SAMFRQ = DFREQ/DECIM
      DO 289 IB = 1,IBLOCK
48    IF(LOBLO) 49,49,101
101   DO 150 LSAMP=1,LDEC
      CALL OCEAN2(NIND,KBLOCK,INDATA(1))
      NIND = NIND+1
      GO TO (140,70,116,105,140),NIND
105   N111 = N111+1
      KCH = INDATA(1)/NCHAN
      ICH = INDATA(1)-(KCH*NCHAN)
      IF(ICH)51,106,51
106   DO 108 IC = 1,KCH
      DO 107 K = 1,KCHAN
107   VAL(NOLD,K) = 512.
      NOLD = NOLD+1
108   CONTINUE
      GO TO 150
  116 IF (NZBLOK.EQ.KBLOCK) GO TO 7000
      NPAR = NPAR + 1
      NZBLOK = KBLOCK
      IF (NPAR.GT.MAXERR) GO TO 5000
      GO TO 7000
```

```
140    DO 145 K = 1,KCHAN
       IDSUB = MCHAN(K)
       IDSUB2 = MCHAN2(K)
       IF (NIND.NE.5) GO TO 7020
       DATA = ATA(IDSUB)*CAL(K) + ATA(IDSUB2)*CAL2(K)
       GO TO 7030
 7020  DATA = (FLOAT(INDATA(IDSUB))/100. - 5.11)*CAL(K)
       DATA = DATA + (FLOAT(INDATA(IDSUB2))/100. - 5.11)*CAL2(K)
 7030  VAL(NOLD,K) = DATA
145    CONTINUE
       NOLD = NOLD+1
       IF(NOLD.GT.MXWAY) NOLD = 1
150    CONTINUE
       IF(IADD.EQ.0.AND.NOLD.GT.1) GO TO 101
       DO 160 K = 1,KCHAN
       IDSUB = MCHAN(K)
        CALL CONVCL(VAL,NOLD,K,2,SUM)
       ATA(IDSUB) = SUM
160    CONTINUE
       NIND = 6
       GO TO 100
49     CALL OCEAN2(NIND,KBLOCK,INDATA(1))
C NIND = 1 MEANS END OF FILE , 2 MEANS PARITY ERROR, 3 MEANS ONES SEARCH
C   NIND = 4 MEANS OCEAN2 WILL RETURN A FLOATING POINT NUMBER BETWEEN
C      0. AND 1023.
       NIND = NIND +1
       GO TO (100,70,60,50,100) , NIND
50     N111 = N111+ 1
       KCH = INDATA(1)/NCHAN
       ICH = INDATA(1) -(KCH*NCHAN)
       IF (ICH) 51,56,51
51     WRITE(6,55) MBLOCK,KBLOCK,IADD
       GO TO 5000
56     DO 58 IC = 1,KCH
       IADD = IADD + 1
       DO 58 K = 1,KCHAN
       IWSUB = INCR(K)+ IADD
58     W(IWSUB) = 0.0
       GO TO 100
    60 IF (NZBLOK.EQ.KBLOCK) GO TO 7000
       NPAR = NPAR + 1
       NZBLOK = KBLOCK
       IF (NPAR.GT.MAXERR) GO TO 5000
       GO TO 7000
70     WRITE(6,75)MBLOCK,KBLOCK
       GO TO 5000
C   STORE DATA IN PSEUDO 2-D ARRAY
100    IADD = IADD + 1
```

```
      DO 200 K = 1,KCHAN
      IDSUB = MCHAN(K)
      IDSUB2 = MCHAN2(K)
      IWSUB = INCR(K)+IADD
      IF (NIND.LT.5) GO TO 7040
      IF (NIND.EQ.5) DATA = ATA(IDSUB)*CAL(K) + ATA(IDSUB2)*CAL2(K)
      IF (NIND.EQ.6) DATA = ATA(IDSUB)
      GO TO 7050
 7040 DATA = (FLOAT(INDATA(IDSUB))/100. - 5.11)*CAL(K)
      DATA = DATA + (FLOAT(INDATA(IDSUB2))/100. - 5.11)*CAL2(K)
 7050 W(IWSUB) = DATA
200   CONTINUE
      IF (IADD.GE.IBLOCK) GO TO 299
289      CONTINUE
C NOW GET FOURIER TRANSFORM
299   MPOW = NPOW -1
      CALL FORT(W1,MPOW,S,-2,IFERR)
      CALL USCRMB(W1,IBLOCK,S)
      IF (KCHAN.LE.1)GO TO 340
      KCH = MINCR/1024
      GO TO (320,30C,300,301),KCH
300   KCH = KCHAN - 1
      GO TO (310,309,308,307) ,   KCH
301   CALL FORT(W5,MPOW,S,-2,IFERR)
      CALL USCRMB(W5,IBLOCK,S)
      GO TO 340
320   KCH   = KCHAN/2
      GO TO (306,305,304,303,302), KCH
302   CALL FORT(W10,MPOW,S,-2,IFERR)
      CALL USCRMB(W10,IBLOCK,S)
303   CALL FORT(W8,MPOW,S,-2,IFERR)
      CALL USCRMB(W8,IBLOCK,S)
304   CALL FORT(W6,MPOW,S,-2,IFERR)
      CALL USCRMB(W6,IBLOCK,S)
305   CALL FORT(W4,MPOW,S,-2,IFERR)
      CALL USCRMB(W4,IBLOCK,S)
306   CALL FORT(W2,MPOW,S,-2,IFERR)
      CALL USCRMB(W2,IBLOCK,S)
      KCH = (KCHAN+1)/2
      GO TO (340,310,309,308,307),KCH
330   KCH =(KCHAN-1)/2
      GO TO (310,309,308,307) , KCH
307   CALL FORT(W9,MPOW,S,-2,IFERR)
      CALL USCRMB(W9,IBLOCK,S)
308   CALL FORT(W7,MPOW,S,-2,IFERR)
      CALL USCRMB(W7,IBLOCK,S)
309   CALL FORT(W5,MPOW,S,-2,IFERR)
       CALL USCRMB(W5,IBLOCK,S)
```

```
310   CALL FORT(W3,MPOW,S,-2,IFERR)
      CALL USCRMB(W3,IBLOCK,S)
  340 IF (IFERR) 350,500,350
350   WRITE (6,355) IFERR
C COEFFICIENTS NOW UNSCRAMBLED,NOW BEGIN SUM AND PRINT
500   IF(IHANN.LE.0) GO TO 880
      DO 800 K = 1,KCHAN
      ISUB = INCR(K) + 1
      ISTAR = INCR(K) + 5
      ILSUB = INCR(K) + IBLOCK - 2
      KLR = ISUB + 2
      KLM = ISUB + 3
      AR3 = 0.0
      AR2 = W(ISUB)
      AR1 = W(KLR)
      AM3 = 0.0
      AM2 = 0.0
      AM1 = W(KLM)
      W(ISUB) = CORNA*(AR2-AR1)
      DO 700 KLP = ISTAR,ILSUB,2
      KM = KLP+1
      AR3 = AR2
      AR2 = AR1
      AR1 = W(KLP)
      AM3 = AM2
      AM2 = AM1
      AM1 = W(KM)
      W(KLR) = CORNB*((2.*AR2)-AR3-AR1)
      W(KLM) = CORNB*((2.*AM2)-AM3-AM1)
      KLR = KLP
      KLM = KM
700   CONTINUE
      ISUB = INCR(K)+2
      AR3 = AR2
      AR2 = AR1
      AR1 = W(ISUB)
      W(KLR) = CORNB*((2.*AR2)-AR3-AR1)
      W(ISUB) = CORNA*(AR1-AR2)
      AM3 = AM2
      AM2 = AM1
      AM1 = 0.
      W(KLM) = CORNB*((2.*AR2)-AR3-AR1)
800   CONTINUE
880   IF(MPRINT.LT.0) GO TO 1300
      KCH = NPOW-6
      IF (KCH.LE.0) KCH = 1
      ISUM = I2TAB(KCH)
      KFIRST = 1
```

```
      KLAST = 5
900   IF(KCHAN.LT.KLAST)KLAST = KCHAN
      WRITE(6,905)IDUSER,MBLOCK,IBLOCK,TODAY,NPAR,N111
      IF(IHANN.GT.0) WRITE(6,36)
      DO 920 K = KFIRST,KLAST
      WRITE(6,915) K,MCHAN(K),(ACHNAM(L,K),L= 1,9),(AUNITS(L,K),L=1,2),CAL(K)
920   CONTINUE
      WRITE(6,925) (MCHAN(K),K=KFIRST,KLAST)
      WRITE (6,935)
      SU = 1
      IHAR = -1
      DO 1200 ICO = 1,33
      DO 950 K= KFIRST,KLAST
      KL = 2*K
      TAPRAY(KL)= 0.0
950   TAPRAY(KL+1) = 0.0
      DO 990 IS = 1,ISUM
      IHAR = IHAR+1
      IADD = 2*IHAR
      DO 980 K=KFIRST,KLAST
      KL = 2*K
      LINCR = INCR(K)
      ISTOR = LINCR+IADD
      IF(IHAR.EQ.(IBLOCK/2)) GO TO 970
      TAPRAY(KL) = TAPRAY(KL) + W(ISTOR +1)
      IF (IHAR.EQ.0) GO TO 980
      TAPRAY(KL+1) = TAPRAY(KL+1)+W(ISTOR+2)
      GO TO 980
970   TAPRAY(KL) = TAPRAY(KL)+W(LINCR+2)
980   CONTINUE
      IF (IHAR.EQ.0) GO TO 1000
990   CONTINUE
      SU = ISUM
1000  KONE = 2*KFIRST
      KTWO =(2*KLAST)+1
      DO 1010 KL = KONE,KTWO
1010  TAPRAY(KL) = TAPRAY(KL)/SU
      WRITE(6,1105) IHAR,(TAPRAY(KL),KL=KONE,KTWO)
1200  CONTINUE
      IF (KLAST.GE.KCHAN ) GO TO 1300
      KFIRST = KLAST + 1
      KLAST =  KFIRST + 4
      GO TO 900
C END OF SUM AND PRINT LOOP, NOW WRITE OUT PUT TAPE
1300  IF(MTAPE)1350,1301,1301
1301  IF(LOBLO-1) 1302,1303,1302
 1302 WRITE (3) ARTAPE
      GO TO 1304
```

```
 1303 WRITE (3) ARTAPE
1304   CONTINUE
C SET UP 256 WORD TAPRAY
       IHARM=(IBLOCK/2)-1
       MAXTAP = 256-(2*KCHAN)
C ZEROTH HARMONIC IS A SPECIAL CASE
       IHAR= 1
       IAR = 0
       DO 1310 K = 1,KCHAN
       ISUB = INCR(K)
       IHAR = IHAR+1
       TAPRAY(IHAR) = W(ISUB+1)
       IHAR= IHAR+1
1310   TAPRAY(IHAR) = 0.0
       DO 1330 IH = 1,IHARM
       IHH = 2*IH
       IHAR = IHAR+1
       TAPRAY(IHAR) =IH
       DO 1320 K=1,KCHAN
       ISUB = IHH + INCR(K)
       TAPRAY(IHAR+1)=W(ISUB+1)
       TAPRAY(IHAR+2)=W(ISUB+2)
       IHAR = IHAR+2
1320   CONTINUE
       IF(IHAR.LT.MAXTAP)GO TO 1330
       IHAR=0
       IF (LOBLO-1) 1322,1323,1322
 1322 WRITE (3) TAPRAY
       GO TO 1330
 1323 WRITE (3) TAPRAY
1330   CONTINUE
C (IBLOCK/2)TH HARMONIC IS ALSO A SPECIAL CASE
       IHAR = IHAR+1
       TAPRAY(IHAR) =IHARM+1
       DO 1340 K=1,KCHAN
       ISUB = INCR(K)
       TAPRAY(IHAR+1) = W(ISUB +2)
       TAPRAY(IHAR+2) = 0.0
1340   IHAR = IHAR+2
       IF(LOBLO-1) 1341,1342,1341
 1341 WRITE (3) TAPRAY
       WRITE(6,1355) MBLOCK,NFILE
       GO TO 1343
 1342 WRITE (3) TAPRAY
       WRITE(6,13425) MBLOCK,IDUSER
1343   CONTINUE
1350   IF(LOBLO.NE.1) MBLOCK = MBLOCK+1
       IF(MBLOCK.GT.NBLOCK) GO TO 5000
```

```
      IF(LOFR.EQ.0) GO TO 12
      IF(LOBLO-1)1351,1352,12
1351  LOBLO = 1
      GO TO 12
1352  LOBLO = 0
      GO TO 12
C WRAP UP ROUTINES
5000  IF(MTAPE.LT.0) GO TO 5500
      END FILE 3
      IF(LOFR.NE.1) GO TO 5500
      END FILE 2
      REWIND 2
      IDTEST = IDUSER
 5200 READ (3,END=5300) ARTAPE
      WRITE (3) ARTAPE
      GO TO 5200
 5300 END FILE 3
      NFILE = NFILE + 1
      IDUSER = IDTEST
      WRITE(6,5305) IDUSER,NFILE
5500  CONTINUE
      IF (MTAPE.GE.0) NFILE = NFILE + 1
      WRITE (6,8001)
      WRITE (6,8002)
      CALL OCEAN3
      GO TO 6000
 6010 CALL RWUNLD
      IF (MTAPE.LT.0) GO TO 6020
      IF (IRWCTL.NE.0) GO TO 6030
      REWIND 3
 6020 WRITE (6,5005)
      CALL EXIT
 6030 REWIND 3
      GO TO 6020
6070   WRITE(6,6075) MBLOCK,NFILE,LOBLO
6075   FORMAT(5X,30H END OF OUTPUT TAPE, MBLOCK = ,I5,9H NFILE = ,
     1 I5,9H LOBLO = ,I5/5X,21HPROCESSING TERMINATED    )
      GO TO 6010
    5 FORMAT (I9,1X,5(I5,5X),F10.0)
    6 FORMAT (7(I5,5X))
    7 FORMAT (2I5,2F10.0,9A4,4X,2A4)
35    FORMAT(46H1 FOURIER TRANSFORM OF OCEAN TIME SERIES DATA  /14H  USE
     1R NUMBER ,I11/16H  OCEAN TAPE HAS,I5,1X,18HCHANNELS, OF WHICH ,
     2 I5,16H WILL BE DONE IN ,I5,10H BLOCKS OF ,I6,13H SAMPLES EACH /
     3 39H  THE FREQUENCY OF DIGITAL SAMPLING WAS ,F10.2,9H SAMP/SEC/)
36    FORMAT(64H0 FOURIER COEFFICIENTS TO BE HANNED AND NORMALIZED (*SQR
     1T(8/3))          )
55    FORMAT(32H  CHANNEL IDENTITY LOST IN BLOCK ,I5, 7H,RECORD,I5,
```

```
     1  6H,SWEEP,I7 )
75     FORMAT(36H  END OF FILE ON INPUT TAPE IN BLOCK,I5,7H,RECORD,I5)
355    FORMAT(15H  TOTAL IFERR =, I10)
905    FORMAT(27H1 SUMMARY COEFFICIENTS FOR ,I10,1H,,I5,11HTH BLOCK OF,
      1 I7,8H SAMPLES, 10X,    /5X,37HIN THIS BLOCK PARITY ERRORS ON TAPE
      2= ,I3,32H,ALL ONES NOT FOUND IN CHANNEL 1,I4,6H TIMES //16X,
      3 1HK,4X, 7HCHANNEL,17X,4HNAME,25X,5HUNITS,3[illegible]AL.FACTOR )
915    FORMAT( 15X,I3,4X,I3, 5X,9A4,8X, 2A4,5X,1PE9.2.
925    FORMAT (2X,4HLAST,1X,5(8X,8HCHANNEL ,I2,4X))
935    FORMAT (2X,4HHARM,8X,5(4HREAL,6X,4HIMAG,8X))
1105   FORMAT (2X,I4,1X,5(3X,1PE9.2,1X,1PE9.2))
13425  FORMAT(24H  COEFFICIENTS FOR BLOCK  ,I5,36H OF SMOOTHED AND DECIMA
      1TED DATA FOR  ,I9,14H WRITTEN ON 02      )
1355   FORMAT(24H  COEFFICIENTS FOR BLOCK  ,I5,17H  WRITTEN IN FILE ,I3,
      1 15H ON OUTPUT TAPE   )
5005   FORMAT(13H0NORMAL EXIT   )
80     FORMAT (20(1X,F5.2))
5305   FORMAT(34H0 SMOOTHED AND DECIMATED DATA FOR ,I9,39H SUCCESSFULLY C
      1OPIED FROM 02 ONTO FILE  ,I2,14H OF TAPE ON 03   /)
 8001  FORMAT (42H1NORMAL COMPLETION OF A PROCESSING REQUEST)
 8002  FORMAT (1H )
       END


       SUBROUTINE CONVOL(VAL,NOLD,KCHAN,MODE,SUM)
       DIMENSION VAL(50,1),WEIGHT(50)
       IF(MODE-1) 10,10,20
10     LDEC = 10
       MXWAY = 21
       WAY = 1.0/21.0
       DO 11 KM = 1,21
11     WEIGHT(KM) = WAY
       KCHAN = LDEC
       NOLD = MXWAY
       WRITE(6,5) LDEC,MXWAY,(WEIGHT(K),K=1,MXWAY)
       RETURN
20     SUM = 0.
       NCOUNT = 0
       NFIR = NOLD-1
30     NFIR = NFIR+1
       NCOUNT = NCOUNT +1
       IF(NCOUNT-MXWAY)17,17,21
17     IF(NFIR-MXWAY)40,40,18
18     NFIR = 1
40     SUM = SUM+VAL(NFIR,KCHAN)
       GO TO 30
```

```
21    SUM = SUM*WEIGHT(1)
      RETURN
5     FORMAT(50H1 ALTERNATE BLOCKS OF DATA DECIMATED BY FACTOR OF , I3/
     1 2X,22H AFTER SMOOTHING WITH ,I5,35H WEIGHTS WITH THE FOLLOWING VA
     2LUES,  /(10X,1PE14.5))
      END


      SUBROUTINE USCRMB (C,M,S)
      DIMENSION C(1),S(1)
      N = M
      ST = C(1)
      C(1) = 0.5*(C(1) + C(2))
      C(2) = 0.5*(ST - C(2))
      K = N/2 - 1
      MSIN = N/4
      C(K+3) = -C(K+3)
      DO 10 I=3,K,2
      IS = (I-1)/2
      IC = MSIN - IS
      ST = S(IS)
      CT = S(IC)
      A1 = C(I)
      B1 = C(I+1)
      L = N - I
      A2 = C(L+2)
      B2 = C(L+3)
      C(I) = 0.5*(A1+A2+(B1+B2)*CT-(A1-A2)*ST)
      C(I+1) = 0.5*(B1-B2-(B1+B2)*ST-(A1-A2)*CT)
      C(L+2) = 0.5*(A1+A2 -(B1+B2)*CT+(A1-A2)*ST)
   10 C(L+3) = 0.5*(B2-B1-(B1+B2)*ST-(A1-A2)*CT)
      RETURN
      END
C
C     FORTRAN OCEAN PACKAGE
C
C          THE FORTRAN OCEAN PACKAGE IS DESIGNED TO DUPLICATE THE
C     'OCEAN' AND 'OCEANB' SUBROUTINE PACKAGES WITH A TAPE WHICH WAS
C     EITHER CREATED BY THE DIGITAL FILTERING SYSTEM OR IS IN THE SAME
C     FORMAT. THE CALLS ARE EQUIVALENT.
C
C     THE CALLING SEQUENCES ARE:
C
C     CALL OCEAN1 (KCHAN,NUNIT,MAXERR,NFILE,NTYPE,NSEARH)
C
C     WHERE,
```

```
C
C           NCHAN = NO. OF CHANNELS DIGITIZED ON THE FORTRAN OCEAN TAPE
C
C           NUNIT = NO. OF UNIT ON WHICH THE FORTRAN OCEAN TAPE IS
C           MOUNTED
C
C           MAXERR  (THIS PARAMETER IS NOT APPLICABLE TO FORTRAN OCEAN
C           BUT MUST BE INCLUDED FOR COMPATIBILITY)
C
C           NFILE = NO. OF DESIRED FILE ON THE FORTRAN OCEAN TAPE
C
C           NTYPE (NOT APPLICABLE BUT IS INCLUDED FOR COMPATIBILITY)
C
C           NSEARH (NOT APPLICABLE BUT IS INCLUDED FOR COMPATIBILITY)
C
C       CALL OCEAN2 (IND,KBLOCK,N)
C
C       WHERE,
C
C           IND = 0 FOR NORMAL RETURN  (RETURNED)
C
C               = 1 FOR END OF INPUT FILE  (RETURNED)
C
C               = 4 IF THE VECTOR RETURNED IS IN FLOATING POINT (FORTRAN
C               VERSION OF OCEAN ONLY) (RETURNED)
C
C           KBLOCK = THE SEQUENTIAL NUMBER OF THE PHYSICAL TAPE BLOCK OF
C           THE NEXT DATA WHICH WILL BE RETURNED BY THE NEXT OCEAN2 CALL.
C           (RETURNED)
C
C           N = FIRST LOCATION OF THE ARRAY INTO WHICH THE CROSS CHANNEL
C           SEQUENCE IS TO BE RETURNED
C
C       CALL OCEAN3
C
C           THIS CALL RESULTS IN A 1 LINE SUMMARY BEING LISTED ON LOGICAL
C       UNIT 6. THIS MAY BE CALLED AT ANY TIME.
C
```

```
      SUBROUTINE OCEAN1 (NCHAN,NUNIT,MAXERR,NFILE,NTYPE,NSEARH)
      DATA KFILE/0/
      KUNIT = NUNIT
      IF (KFILE.GT.0) GO TO 20
   10 REWIND KUNIT
      KFILE = 1
      KSTART = 1
   20 IF (KFILE.GT.NFILE) GO TO 10
      IF (KFILE.EQ.NFILE.AND.KSTART.EQ.0) GO TO 10
      KSKIP = NFILE - KFILE
      IF (KSKIP.LE.0) GO TO 50
      DO 40 I=1,KSKIP
   30 READ (NUNIT,END=40) IDUMMY
      GO TO 30
   40 CONTINUE
   50 KFILE = NFILE
      KSTART = 1
      KMAX = 256
      KCTR = KMAX + 1
      KREAD = 0
      RETURN
      ENTRY OCEAN2 (IND,KBLOCK,X)
      DIMENSION X(1),DATA(256)
      IF (KCTR.GT.KMAX) GO TO 70
   55 DO 60 I=1,NCHAN
      X(I) = DATA(KCTR)
   60 KCTR = KCTR + 1
      IND = 4
      KBLOCK = KREAD
      RETURN
   70 READ (KUNIT,END=80) KMAX,NCHAN,(DATA(J),J=1,KMAX)
      KSTART = 0
      IF (KMAX.EQ.0) GO TO 70
      KCTR = 1
      KREAD = KREAD + 1
      GO TO 55
   80 KFILE = KFILE + 1
      KSTART = 1
      IND = 1
      RETURN
      ENTRY OCEAN3
      WRITE (6,4001) KREAD
      RETURN
 4001 FORMAT ('0OCEAN 3 CALLED (FORTRAN VERSION).',I10,' TAPE BLOCKS PRO
     1CESSED')
      ENTRY RWUNLD
      REWIND KUNIT
      KFILE = 1
```

```
      KSTART = 1
      RETURN
      END
C
C     THIS SUBROUTINE WHEN CALLED MOVES THE TAPE ON LOGICAL UNIT NUNIT
C     PAST KSKIP END OF FILE MARKS. THE RECORDS SKIPPED OVER MUST BE IN
C     FORTRAN BINARY. IF KSKIP IS ZERO OR NEGATIVE THE ROUTINE RETURNS
C     WITHOUT MOVING THE TAPE.
C



      SUBROUTINE SKPFL (KSKIP,NUNIT)
      IF (KSKIP.LT.1) RETURN
      DO 20 I=1,KSKIP
   10 READ (NUNIT,END=20) IDUMMY
      GO TO 10
   20 CONTINUE
      RETURN
      END
C         FORT, ONE-DIMENSIONAL FINITE COMPLEX FOURIER TRANSFORM.        FORT 002
C                                                                        FORT 003



      SUBROUTINE FORT(A,M,S,IFS,IFERR)                                   FORT 004
C                                                                        FORT 005
C     FOURIER TRANSFORM SUBROUTINE, PROGRAMMED IN SYSTEM/360,            FORT 006
C     BASIC PROGRAMMING SUPPORT, FORTRAN IV. FORM C28-6504               FORT 007
C     THIS DECK SET UP FOR IBSYS ON IBM 7094.                            FORT 008
C
C    THIS DECK MODIFIED TO ALLOW COMPUTATION OF SINE TABLE ( S(J) )
C      WITH M = 14, FOR USE WITH SERIES OF 2**14 REAL VALUES
C     BY ADDITION OF STATEMENTS 6 AND 7 ANDCHANGING 3 FROM
C      IF(M-13) 5,5,2  TO IF(M-13) 5,5,6
C                                                                        FORT 009
C     DOES EITHER FOURIER SYNTHESIS,I.E.,COMPUTES COMPLEX FOURIER SERIESFORT 010
C     GIVEN A VECTOR OF N COMPLEX FOURIER AMPLITUDES,OR, GIVEN A VECTOR FORT 011
C     OF COMPLEX DATA X DOES FOURIER ANALYSIS, COMPUTING AMPLITUDES.     FORT 012
C     A IS A COMPLEX VECTOR OF LENGTH N=2**M COMPLEX NOS. OR 2*N REAL    FORT 013
C     NUMBERS. A IS TO BE SET BY USER.                                   FORT 014
C     M  IS AN INTEGER O.LT.M.LE.13, SET BY USER.                        FORT 015
C     S IS A VECTOR S(J)= SIN(2*PI*J/NP ), J=1,2,....,NP/4-1,            FORT 016
C     COMPUTED BY PROGRAM.                                               FORT 017
C     IFS IS A PARAMETER TO BE SET BY USER AS FOLLOWS-                   FORT 018
C     IFS=0 TO SET NP=2**M AND SET UP SINE TABLE.                        FORT 019
```

```
C       IFS=1 TO SET N=NP=2**M, SET UP SIN TABLE, AND DC FOURIER
C       SYNTHESIS, REPLACING THE VECTOR A BY
C
C       X(J)= SUM OVER K=0,N-1 OF A(K)*EXP(2*PI*I/N)**(J*K),
C       J=0,N-1, WHERE I=SQRT(-1)
C
C       THE  X'S  ARE STORED WITH   RE X(J) IN CELL  2*J+1
C       AND  IM X(J)  IN CELL  2*J+2  FOR  J=0,1,2,...,N-1.
C       THE  A'S  ARE STORED IN THE SAME MANNER.
C
C       IFS=-1   TO SET  N=NP=2**M,SET UP SIN TABLE, AND DO FOURIER
C       ANALYSIS, TAKING THE INPUT VECTOR A AS X AND
C       REPLACING IT BY THE A  SATISFYING THE ABOVE FOURIER SERIES.
C       IFS=+2 TO DO FOURIER SYNTHESIS ONLY, WITH A PRE-COMPUTED S.
C       IFS=-2 TO DO FOURIER ANALYSIS ONLY, WITH A PRE-COMPUTED S.
C       IFERR   IS SET BY PROGRAM TO-
C       =0 IF NO ERROR DETECTED.
C       =1 IF M IS OUT OF RANGE., OR, WHEN IFS=+2,-2, THE
C       PRE-COMPUTED S TABLE IS NOT LARGE ENOUGH.
C       =-1 WHEN IFS =+1,-1, MEANS ONE IS RECOMPUTING S TABLE
C       UNNECESSARILY.
C
C       NOTE- AS STATED ABOVE, THE MAXIMUM VALUE OF M FOR THIS PROGRAM
C       ON THE IBM 7094 IS 13. FOR 360 MACHINES HAVING GREATER STORAGE
C       CAPACITY, ONE MAY INCREASE THIS LIMIT BY REPLACING 13 IN
C       STATEMENT 3 BELOW BY LOG2 N, WHERE N IS THE MAX. NO. OF
C       COMPLEX NUMBERS ONE CAN STORE IN HIGH-SPEED CORE.  ONE MUST
C       ALSO ADD MORE  DO  STATEMENTS TO THE BINARY SORT ROUTINE
C       FOLLOWING STATEMENT  24  AND CHANGE THE EQUIVALENCE STATEMENTS
C       FOR THE  K'S.
C
        DIMENSION A(1), S(1), K(14)
        EQUIVALENCE (K(13),K1),(K(12),K2),(K(11),K3),(K(10),K4)
        EQUIVALENCE (K( 9),K5),(K( 8),K6),(K(7),K7),(K( 6),K8)
        EQUIVALENCE (K( 5),K9 ),(K( 4),K10),(K( 3),K11),(K( 2),K12)
        EQUIVALENCE (K( 1),K13),( K(1),N2)
        IF(M)2,2,3
      3 IF(M-13) 5,5,6
C THE FOLLOWING TWO STATEMENTS ADDED BY J GARRETT , SEE ABOVE
      6 IF(M-14) 7,7,2
      7 IF(IFS) 2,5,2
      2 IFERR=1
      1 RETURN
      5 IFERR=0
        N=2**M
        IF( IABS(IFS) - 1 ) 200,200,10
C       WE ARE DOING TRANSFORM ONLY. SEE IF PRE-COMPUTED
C       S TABLE IS SUFFICIENTLY LARGE
```

```
   10 IF( N-NP )20,20,12                                              FORT 065
   12 IFERR=1                                                         FORT 066
      GO TO 200                                                       FORT 067
C     SCRAMBLE A, BY SANDE'S METHOD                                   FORT 068
   20 K(1)=2*N                                                        FORT 069
      DO 22 L=2,M                                                     FORT 070
   22 K(L)=K(L-1)/2                                                   FORT 071
      DO 24 L=M,12                                                    FORT 072
   24 K(L+1)=2                                                        FORT 073
C     NOTE EQUIVALENCE OF KL AND K(14-L)                              FORT 074
C     BINARY SORT-                                                    FORT 075
      IJ=2                                                            FORT 076
      DO 30 J1=2,K1,2                                                 FORT 077
      DO 30 J2=J1,K2,K1                                               FORT 078
      DO 30 J3=J2,K3,K2                                               FORT 079
      DO 30 J4=J3,K4,K3                                               FORT 080
      DO 30 J5=J4,K5,K4                                               FORT 081
      DO 30 J6=J5,K6,K5                                               FORT 082
      DO 30 J7=J6,K7,K6                                               FORT 083
      DO 30 J8=J7,K8,K7                                               FORT 084
      DO 30 J9=J8,K9,K8                                               FORT 085
      DO 30 J10=J9,K10,K9                                             FORT 086
      DO 30 J11=J10,K11,K10                                           FORT 087
      DO 30 J12=J11,K12,K11                                           FORT 088
      DO 30 JI=J12,K13,K12                                            FORT 089
      IF(IJ-JI)28,30,30                                               FORT 090
   28 T=A(IJ-1 )                                                      FORT 091
      A(IJ-1)=A(JI-1)                                                 FORT 092
      A(JI-1)=T                                                       FORT 093
      T=A(IJ)                                                         FORT 094
      A(IJ)=A(JI)                                                     FORT 095
      A(JI)=T                                                         FORT 096
   30 IJ=IJ+2                                                         FORT 097
      IF(IFS)32,2,36                                                  FORT 098
C     DOING FOURIER ANALYSIS,SO DIV. BY N AND CONJUGATE.              FORT 099
   32 FN = N                                                          FORT 100
      DO 34 I=1,N                                                     FORT 101
      A(2*I-1) = A(2*I-1)/FN                                          FORT 102
   34 A(2*I)=-A(2*I)/FN                                               FORT 103
C     SPECIAL CASE- L=1                                               FORT 104
   36 DO 40 I=1,N,2                                                   FORT 105
      T = A(2*I-1)                                                    FORT 106
      A(2*I-1) =T + A(2*I+1)                                          FORT 107
      A(2*I+1)=T-A(2*I+1)                                             FORT 108
      T=A(2*I)                                                        FORT 109
      A(2*I) = T + A(2*I+2)                                           FORT 110
   40 A(2*I+2)= T - A(2*I+2)                                          FORT 111
      IF(M-1) 2,1  ,50                                                FORT 112
```

```
C     SET FOR L=2
   50 LEXP1=2
C     LEXP1=2**(L-1)
      LEXP=8
C     LEXP=2**(L+1)
      NPL= 2**MT
C     NPL = NP* 2**-L
   60 DO 130 L=2,M
C     SPECIAL CASE- J=0
      DO 80 I=2,N2,LEXP
      I1=I + LEXP1
      I2=I1+ LEXP1
      I3 =I2+LEXP1
      T=A(I-1)
      A(I-1) = T +A(I2-1)
      A(I2-1) = T-A(I2-1)
      T =A(I)
      A(I) = T+A(I2)
      A(I2) = T-A(I2)
      T= -A(I3)
      TI = A(I3-1)
      A(I3-1) = A(I1-1) - T
      A(I3   ) = A(I1 )   - TI
      A(I1-1) = A(I1-1) +T
   80 A(I1)   = A(I1   )  +TI
      IF(L-2) 120,120,90
   90 KLAST=N2-LEXP
      JJ=NPL
      DO 110 J=4,LEXP1,2
      NPJJ=NT-JJ
      UR=S(NPJJ)
      UI=S(JJ)
      ILAST=J+KLAST
      DO 100 I= J,ILAST,LEXP
      I1=I+LEXP1
      I2=I1+LEXP1
      I3=I2+LEXP1
      T=A(I2-1)*UR-A(I2)*UI
      TI=A(I2-1)*UI+A(I2)*UR
      A(I2-1)=A(I-1)-T
      A(I2  )=A(I    ) - TI
      A(I-1) =A(I-1)+T
      A(I)   =A(I)+TI
      T=-A(I3-1)*UI-A(I3)*UR
      TI=A(I3-1)*UR-A(I3)*UI
      A(I3-1)=A(I1-1)-T
      A(I3)    =A(I1   )-TI
      A(I1-1)=A(I1-1)+T
```

```
  100 A(I1)    =A(I1)    +TI
C     END OF I LOOP
  110 JJ=JJ+NPL
C     END OF J LOOP
  120 LEXP1=2*LEXP1
      LEXP = 2*LEXP
  130 NPL=NPL/2
C     END OF L LOOP
  140 IF(IFS)145,2,1
C     DOING FOURIER ANALYSIS. REPLACE A BY CONJUGATE.
  145 DO 150 I=1,N
  150 A(2*I) =-A(2*I)
  160 GO TO 1
C     RETURN
C     MAKE TABLE OF S(J)=SIN(2*PI*J/NP),J=1,2,....NT-1,NT=NP/4
  200 NP=N
      MP=M
      NT=N/4
      MT=M-2
      IF(MT) 260,260,205
  205 THETA=.7853981634
C     THETA=PI/2**(L+1)     FOR L=1
  210 JSTEP = NT
C     JSTEP = 2**( MT-L+1 ) FOR L=1
      JDIF = NT/2
C     JDIF = 2**(MT-L)  FOR L=1
      S(JDIF) = SIN(THETA)
      IF (MT-2)260,220,220
  220 DO 250 L=2,MT
      THETA = THETA/2.
      JSTEP2 = JSTEP
      JSTEP = JDIF
      JDIF = JDIF/2
      S(JDIF)=SIN(THETA)
      JC1=NT-JDIF
      S(JC1)=COS(THETA)
      JLAST=NT-JSTEP2
      IF(JLAST-JSTEP)250,230,230
  230 DO 240 J=JSTEP,JLAST,JSTEP
      JC=NT-J
      JD=J+JDIF
  240 S(JD)=S(J)*S(JC1)+S(JDIF)*S(JC)
  250 CONTINUE
  260 IF(IFS)20,1,20
      END
```

```
C
C SPECTRUM AND CROSS SPECTRUM STATISTICS FROM FOURIER
C COEFFICIENT TAPE PRODUCED BY 'FTOR' PROGRAM ON IBM
C SYSTEM 360 MODEL 67
C
C LAST REVISION JANUARY 27,1969        JOHN GARRETT
C
C THIS PROGRAM READS FOURIER COEFFICIENTS FROM TAPE PRODUCED BY FTOR
C PROGRAM, AND FROM THE APPROPRIATE SUMS OF THESE PRODUCES SPECTRA AND
C COSPECTRA. THE SUMS USED MAY BE FIXED WITH FREQUENCY OR MAY GO IN HALF
C OCTAVES FROM A SPECIFIED LOW FREQUENCY. AN AVERAGE, STANDARD DEVIATION
C AND LINEAR COEFFICIENT OF REGRESSION OVER THE IBMAX BLOCKS USED (SEE
C FTOR DESCRIPTION) ARE GIVEN FOR EACH VALUE OF SPECTRAL DENSITY.
C AT EACH FREQUENCY, THE COSPECTRUM BETWEEN (1) AND (2) IS GIVEN BY
C       ( R(1)*R(2) + I(1)*I(2))/ 2.0
C AND THE QUADRATURE SPECTRUM BY
C       ( R(2)*I(1) - R(1)* I(2))/ 2.0
C WHERE ( R(N) + (I(N)*SQRT(-1)) ) IS THE COMPLEX FOURIER COEFFICIENT
C OF SERIRES (N) AT THAT FREQUENCY
C
C     A VARIETY OF PLOTTED OUTPUT IS AVAILABLE.  IN ALL A HORIZONTAL BAR
C INDICATES THE FREQUENCY INTERVAL INCLUDED IN THE ESTIMATE PLOTTED, AND
C A VERTICAL BAR INDICATES THE EXPECTED STANDARD DEVIATION OF THE
C ESTIMATE (= STD.DEV. OF BLOCKS AVERAGED TO GIVE ESTIMATE/ SQRT(NUMBER
C     OF BLOCKS))
C
C THE FOLLOWING SUBROUTINES MUST BE SUPPLIED BY USER
C        PHASES
C        PLVAL,TIC,LABEL
C
C THE FOLLOWING LOGICAL INPUT/OUTPUT UNITS ARE USED BY THIS PROGRAM
C        3= (TAPE) SUPPLYING COEFFICIENTS AND IDENTIFICATION AS
C           PRODUCED BY FTOR
C        5= (CARDS) CONTROL PARAMETERS
C        6= PRINTED OUTPUT
C
C THE FOLLOWING INPUT IS REQUIRED
C
C A CARD IS REQUIRED TO IDENTIFY YOUR GRAPHICAL OUTPUT FOR THE COMPUTING
C CENTRE STAFF. IT MUST BE PRESENT WHETHER PLOTS ARE PRODUCED OR NOT.
C THE FIRST 72 COLUMNS OF THIS CARD WILL BE REPRODUCED ON THE BEGINNING
C OF YOUR PLOT. THIS CARD APPEARS ONLY ONCE IN THE JOB AND IS THE FIRST
C DATA CARD. THE FOLLOWING SET OF CARDS IS PRESENT FOR EACH FILE OF
C FOURIER COEFFICIENTS TO BE PROCESSED.
C
C  FIRST CARD,IN COLUMN
C     1-9    IDUSER = USER IDENTIFICATION NUMBER FOR DATA DESIRED
C     14-15  ICMAX = NUMBER OF CHANNELS TO BE USED (MAX 10)
```

```
C     24-25 IBMAX = NUMBER OF DATA BLOCKS FOR STATISTICS
C    34-35 IBSTAR = STATISTICS START WITH BLOCK NO. IBSTAR
C    44-45 NFILE = DATA IS IN NFILE-TH FILE ON FOURIER COEFFICIENT TAPE
C     54    IAXIS = 0 (BLANK) IF PLOT AXES TO BE SET BY PROGRAM
C                 = 1 IF AXES TO BE SET BY USER
C     55    IPLOT = 0 IF NO PLOTTED OUTPUT DESIRED
C                =1 IF SPECTRAL DENSITY TO BE PLOTTED AGAINST FREQUENCY
C                =2 IF LOG10 SPECTRAL DENSITY TO BE PLOTTED AGAINST FREQUENCY
C                =3 IF LOG10 SPECTRAL DENSITY TO BE PLOTTED AGAINST LOG10
C                    FREQUENCY
C                =4 IF      (FREQ*SPECTRAL DENSITY) TO BE PLOTTED
C                   AGAINST LOG10 FREQUENCY
C                =5 SAME AS IPLOT=1 EXCEPT COHERENCE AND PHASE PLOTTED
C                   INSTEAD OF CO AND QUAD SPECTRA
C                =6 SAME AS =2 EXCEPT COHERENCE AND PHASE PLOTTED INSTEAD
C                    CF CO AND QUAD
C                =7 SAME AS 3 EXCEPT COHERENCE AND PHASE INSTEAD OF CO+QU
C                = 8 SAME AS 4 WITH COHERENCE AND PHASE INSTEAD OF CO + QU
C     65    IPHASE = 0 FOR NO PHASE CORRECTIONS
C                 = 1 FOR PHASES TO BE CORRECTED.
C
C  CARD INSERTED ONLY IF IAXIS = 1
C     IN COLUMN
C    1-10   VALUE OF ORIGIN FOR SPECTRUM AND COSPECTRUM AXIS(F10.)
C    11-20  UNITS PER INCH FOR SPECTRUM AND COSPECTRUM AXIS (F10.)
C                  AXIS WILL BE 5.00 INCHES LONG
C    21-30  VALUE OF ORIGIN FOR QUADSPECTRUM AXIS  (F10.)
C    31-40  UNITS PER INCH FOR QUAD SPECTRUM AXIS (F10.) AXIS WILL BE
C                 5.00 INCHES LONG.  (COHERENCE AND PHASE WILL BE
C                 SCALED BY PROGRAM IF PLOTTED INSTEAD OF CO AND QUAD.)
C    41-50 VALUSE OF ORIGIN FOR FREQUENCY AXIS (F10. )
C    51-60  UNITS PER INCH FOR FREQUENCY AXIS (F10.)
C    61-70  LENGTH CF FREQUENCY AXIS IN INCHES (F10.)
C  N.B. WHEN LOG10 PLOTS HAVE BEEN REQUESTED NUMBERS ABOVE MUST ALL
C    REFER TO LOG10,.E.G. UNITS PERINCH = 1.00 MEANS 1 DECADE PER INCH
C
C NEXT CARD,IN COLUMN
C     5     LINOCT = 0 FOR CONSTANT BANDWIDTH,GIVEN BY BANDW BELOW
C                  = 1 FOR EXPONENTIAL BANDWIDTHS ( GIVES LOG10 FREQ.
C                        SCALE IN ALL PLOTS  )
C     6-15  STRFRQ = APPROXIMATE CENTER FREQUENCY OF FIRST POINT OF
C                    SPECTRUM, IN HERTZ. (MUST INCUDE A DECIMAL POINT)
C                    FIRST BAND WILL INCLUDE ZEROTH HARMONIC IF STRFRQ
C                    IS LESS THAN BANDW
C     16-25 BANDW = APPROX. BANDWIDTH FOR FIXED BANDWIDTH SPECTRA,
C                   IN HERTZ. (MUST INCLUDE A DECIMAL POINT)
C     30     INDOW = 1 IF FOURIER COEFFCIENTS TO BE HANNED BEFORE
C                   SPECTRA COMPUTED
```

```
C                    = 0 IF NOT
C     SUBSEQUENT ICMAX CARDS
C        4-5    CHANNEL NUMBER OF A CHANNEL FOR WHICH SPECTRA ARE WANTED
C               NUMBER IS USUALLY NUMBER OF A-D CHANNEL USED FOR CONVERSION
C        14-15,19-20,24-25,29-30 TO 59-60 , CHANNEL NUMBERS OF UP TO ICMAX
C               CHANNELS FOR WHICH CROSS SPECTRA WITH CHANNEL GIVEN IN
C               COLS.4-5 ARE DESIRED. SPECTRUM IS HERE CONSIDERED AS CROSS
C               SPECTRUM OF CHANNEL WITH ITSELF, I.E. THE NUMBER IN 4-5
C               MUST REAPPEAR IF SPECTRUM IS TO BE OBTAINED. ALSO,CROSS
C               SPECTRA ARE DONE ONLY IF EACH CHANNEL APPEARS IN THE LIST
C               ON THE OTHER CHANNELS CARD. THUS TO GET SPECTRUM FOR
C               CHANNEL 2 AND CROSS SPECTRUM BETWEEN 2 AND CHANNEL 8, THERE
C               MUST BE A CARD WITH  2 IN COL.5 AND BOTH 2 AND 8 IN THE LIST
C               AND ANOTHER CARD WITH 8 IN COL.5 AND 2 IN THE LIST.
C
C     PHASE CORRECTION DECK( INSERT ONLY IF IPHASE NOT ZERO )
C       PHASE CORRECTIONS APPLIED WILL BE OBTAINED BY LINEAR INTERPOLATION
C        BETWEEN VALUES SUPPLIED AT FREQUENCIES LISTED BELOW
C     FIRST K CARDS( K LESS THAN 6 )
C        1-10,11-20,....,71-80 , FREQUENCIES( F10.4 ) AT WHICH PHASE
C          CORRECTIONS ARE TO BE SUPPLIED ( UP TO 48 OF THEM )
C             IF LESS THAN THE FULL 48 FREQUENCIES ARE SUPPLIED, THEN
C               THE LAST FREQUENCY MUST BE LEFT BLANK.
C     SUBSEQUENT ICMAX SETS OF K CARDS EACH
C        1-10,11-20,....,71-80 , PHASE CORRECTIONS( F10.4 ) TO BE APPLIED
C          AT THE ABOVE FREQUENCIES. EACH SET CONTAINS THE CORRECTIONS
C             FOR A GIVEN CHANNEL, AND THE SETS ARE IN THE SAME ORDER AS THE
C             SPECTRUM CARDS. IF NO CORRECTIONS ARE TO BE APPLIED TO A
C             CHANNEL, THE K CARDS FOR THAT CHANNEL SHOULD BE BLANK.
C                 CORRECTIONS MUST BE IN RADIANS. A POSITIVE CORRECTION WILL
C             CAUSE THE CORRECTED PHASE TO LEAD THE UNCORRECTED ONE.
C
C     LAST CARD MUST BE BLANK UNLESS ANOTHER FILE IS TO BE PROCESSED, IN
C     WHICH CASE A COMPLETE NEW SEQUENCE OF CARDS APPROPRIATE TO THE NEW
C     FILE SHOULD FOLLOW.
C
      DIMENSION ARTAPE(256),TAPRAY(256),PHI(10,10,32),PHISQ(10,10,32),
     1 PHIBL(10,10,32),KCHA(10),KCHB(10,10),ICH(10,10),FREQ(32),NEND(33)
     2,BANDW(32),A(32),AD(32),B(32),BD(32), ACHNAM(9,10),AUNITS(2,10),
     3 CAL(10),MCHAN(10),INDCH(12),Z(256),I2TAB(14),AE(32),BE(32),
     4 POS(32), DC(10,10),DCSQ(10,10),DCBL(10,10),PHASE(50,12)
     5,AR1(10),AR2(10),AR3(10),AM1(10),AM2(10),AM3(10),BR1(10,10),
     6 BR2(10,10),BR3(10,10),BM1(10,10),BM2(10,10),BM3(10,10)
     7,COSP(10,10),QUSP(10,10),POSL(32),POSU(32),NLOGBW(9)
      DIMENSION GTITLE(18)
      EQUIVALENCE  (TAPRAY(100),ICH(1,1)),(ARTAPE(1),Z(1)),(Z(1),IDUSER)
     1,(Z(2),MBLOCK),(Z(3),IBLOCK),(Z(4),NTAP),(Z(5),KCHAN),
     2 (Z(6),SAMFRQ),(Z(11),MCHAN(1)),(Z(31),ACHNAM(1,1)
```

```
      3 ),(Z(121),AUNITS(1,1)),(Z(141),CAL(1)),(Z(151),INDCH(1)),
      4 (Z(163),I2TAB(1)),(Z(210),TAPRAY(1))
      5, (Z(10),IHANN),(Z(210),IAR)
       DATA NLOGBW(1),NLOGBW(2),NLOGBW(3),NLOGBW(4),NLOGBW(5),NLOGBW(6),
      1 NLOGBW(7),NLOGBW(8),NLOGBW(9)/1,2,3,4,6,8,11,15,20 /
       CORNA = 1./2.00000
       CORNA = SQRT(CORNA)
       CORNB = 1.0C/6.000
       CORNB = SQRT(CORNB)
       LOPT = 0
       REWIND 3
       IFILE = 1
       KBEGIN = 1
       YREORG = 11.
       READ (5,6) GTITLE
1      READ(5,15,END=5020) IDTEST,ICMAX,IBMAX,IBSTAR,NFILE,IPLOT,IPHASE
       IF (IDTEST.EQ.0) GO TO 5020
       IAXIS = IPLOT/10
       IPLOT = IPLCT-(10*IAXIS)
       FRAXLN = 4.00
       IF(IAXIS.GT.0) READ(5,5) XRES1,DXRES1,XRES2,DXRES2,XMIN3,DX3,
      1 FRAXLN
       TRANS = FRAXLN+4.00
       IF (IFILE.LT.NFILE) GO TO 19
       IF (IFILE.EC.NFILE.AND.KBEGIN.EQ.1) GO TO 19
       REWIND 3
       IFILE = 1
       KBEGIN = 1
19     READ(5,16) LINOCT,STRFRQ,BAND,INDOW
       IF (IPLOT.LE.0) GO TO 20
       IF (LOPT.GT.0) GO TO 20
       CALL PLOTS
       CALL SYMBOL (0.,0.,0.14,GTITLE,0.,72)
       CALL PLOT (0.,3.,-3)
       LOPT = 1
20     DO 21 I = 1,10
       KCHA(I)=0
       DO 21 J = 1,10
       ICH(I,J)=0
       KCHB(I,J) = 0
21      CONTINUE
       DO 30 ICD = 1,ICMAX
       READ (5,25) KCHA(ICD),(ICH(ICD,J),J=1,10)
       IF (KCHA(ICD).GT.0)GO TO 30
       ICMAX = ICD
       GO TO 31
30     CONTINUE
31     DO 40 KA = 1,ICMAX
```

```
      KB = 0
      DO 39 J = 1,10
      IF (KCHA(KA).GT.ICH(KA,J)) GO TO 39
      KB = KB+1
      KCHB(KA,KB) = ICH(KA,J)
39    CONTINUE
40    CONTINUE
      IF( IPHASE.EQ.0 ) GO TO 41
      CALL PHASES( 0,Z,CO,QU,IFB,FREQ,NEND,BANDW,PHASE,KCA,KCB,FUNDFR,
     1 ICMAX,MCHAN, MAXIF, RAD , KCHA)
   41 KSKIP = NFILE - IFILE
      IF (KSKIP.GT.0) CALL SKPFL (KSKIP,3)
      IFILE = NFILE
      READ (3,END=1108) ARTAPE
      KBEGIN = 0
      IF(IDTEST -IDUSER) 4900,54,4900
54    IF(IBSTAR - MBLOCK) 59,65,55
55    DO 56 N = 1,NTAP
   56 READ (3,END=1108) TAPRAY
      READ (3,END=1108) ARTAPE
      GO TO 54
59    IB =(IBSTAR  + IBMAX-1)-MBLOCK
      IF (IB)  4700,60,60
60    IBMAX = IBMAX - (MBLOCK -IBSTAR)
      IBSTAR = MBLOCK
C  PRINT INTENTIONS
65    IS = 0
      WRITE (6,62) IDUSER,IFILE,ICMAX,IBMAX,IBSTAR
      IF(IHANN.GT.0) INDOW = 0
C EXCHANGE REAL CHANNEL NUMBERS FOR INDICES USED ON TAPE
      DO 67 K = 1,10
      IT = 0
      KC = KCHA(K)
      KIS = K - IS
      KCHA(KIS) = 0
      IF(KC.LE.0) GO TO 659
      KCHA(KIS) = INDCH(KC)
      IF (INDCH(KC).EQ.0)IS = IS+1
659   DO 66 I = 1,10
      IC = KCHB(K,I)
      KIT = I - IT
      KCHB(KIS,KIT) = 0
      IF(IC.LE.0) GO TO 66
      KCHB (KIS,KIT) = INDCH(IC)
      IF (INDCH(IC).EQ.0) IT =IT+1
66    CONTINUE
67    CONTINUE
      NHAR = 256/((2*KCHAN)+1)
```

```
C SET UP SUMMING ROUTINE, FIRST GETTING FUNDAMENTAL FREQUENCY
      JBLOCK = IBLOCK/2
      TBLOCK = IBLOCK
      FUNDFR = SAMFRQ/TBLOCK
      BLKLNG = TBLOCK/SAMFRQ
      NSTART = STRFRQ/FUNDFR
      IFRSCL=0
      IF(LINOCT) 70,70,76
C GET NUMBER OF HARMONICS FOR FIXED BANDWIDTH
70    NBAND = BAND/FUNDFR
      IF(NBAND.EQ.0) NBAND=1
      BAND = NBAND
      BAND = BAND*FUNDFR
      BANHAF = BAND/2.0
      J = NBAND/2
      NSTART = NSTART - J
      IF(NSTART.LT.0)NSTART = 0
C SET NUMBER OF FIXED BANDS
      MAXIF = (JBLOCK -NSTART)/NBAND
      IF (MAXIF.GT.32) MAXIF = 32
      STRFRQ = NSTART
      STRFRQ = STRFRQ*FUNDFR
      FREQ(1) = STRFRQ+((BAND-FUNDFR)/2.)
      POS(1)=FREQ(1)
      NEND(1) = NSTART +NBAND-1
      BANDW(1) = BAND
      POSL(1) = FREQ(1)-BANHAF
      POSU(1) = FREQ(1)+BANHAF
      DO 73 I = 2,MAXIF
      J = I-1
      FREQ(I) = FREQ(J) + BAND
      POS(I)=FREQ(I)
      POSU(I) = FREQ(I)+BANHAF
      POSL(I) = POSU(J)
      BANDW(I) = BAND
73    NEND(I) = NEND(J)+ NBAND
      GO TO 80
C     SET UP FOR LOGARITHMIC SUMMING
76    IF(NSTART.NE.1) NSTART=1
      NEND(1) = 1
      BANDW(1)= FUNDFR
      POSL(1) = FUNDFR/2.0
      POSU(1) = FUNDFR+POSL(1)
      FREQ(1) = SQRT(POSL(1)*POSU(1))
      POS(1)=FREQ(1)
      DO 74 I = 2,9
74    NEND(I) = NLOGBW(I)
      BAND = NEND(9)
```

```
      BAND = BAND+0.50
      I = 9
77    I = I+1
      BAND = BAND*1.33352
      NEND(I) = BAND
      MAXIF = I
      IF(NEND(I).LT.JBLOCK) GO TO 77
      NEND(I) = JBLOCK
      DO 78 I = 2,MAXIF
      J = I-1
      BAND = NEND(I)-NEND(J)
      BANDW(I) = BAND*FUNDFR
      BAND = NEND(I)
      POSU(I) = (BAND+0.50)*FUNDFR
      POSL(I) = POSU(J)
      FREQ(I)=SQRT(POSL(I)*POSU(I))
   78 POS(I)=FREQ(I)
C NOW GET SET TO READ SOME DATA
80    KBLOCK = 1
      IF (IHANN.GT.0.AND.NEND(MAXIF).EQ.JBLOCK) NEND(MAXIF) = JBLOCK - 1
   81 NSTARW = NSTART - INDOW
      DO 100  IFR= 1,MAXIF
      DO 99 KA = 1,10
      DO 98 KB = 1,10
      DC(KA,KB) = 0.0
      DCSQ(KA,KB) = 0.0
      DCBL(KA,KB) = 0.0
      PHI(KA,KB,IFR) = 0.0
      PHISQ(KA,KB,IFR) =0.0
98    PHIBL(KA,KB,IFR) = 0.0
99    CONTINUE
100   CONTINUE
      BL = 0.0
      BLSQ = 0.0
C BEGINNING OF BLOCK LOOP
180   BLOCK = MBLOCK
      DO 181 KBC = 1,10
      AR1(KBC) = 0.0
      AR2(KBC) = 0.0
      AR3(KBC) = C.0
      AM1(KBC) = 0.0
      AM2(KBC) = 0.0
      AM3(KBC) = 0.0
      DO 181 KAC = 1,10
      COSP(KAC,KBC) = 0.0
      QUSP(KAC,KBC) = 0.0
      BR1(KAC,KBC) = 0.0
      BR2(KAC,KBC) = 0.0
```

```
      BR3(KBC,KAC) = 0.0
      BM1(KBC,KAC) = 0.0
      BM2(KAC,KBC) = 0.0
      BM3(KAC,KBC) = 0.0
181   CONTINUE
      BL = BL + BLOCK
      BLSQ = BLSQ + (BLOCK*BLOCK)
      IFR = 1
      IHARM = -1
185   DO 1000 NT = 1,NTAP
      NCAR = NT
      READ (3,END=1108) TAPRAY
190   DO 990 IH = 1,NHAR
      IF(IFR.GT.MAXIF) GO TO 1000
19005 IHARM = IHARM + 1
      IHARM2 = IHARM-INDOW
      IF(IHARM2.EQ.0) GO TO 191
      IF(IHARM.LT.NSTARW) GO TO 990
      IF(IHARM2.LE.NEND(IFR)) GO TO 191
      DO 850 KA = 1,ICMAX
      KCA = KCHA(KA)
      IF(KCA.LE.0) GO TO 850
      DO 850 KB = 1,ICMAX
      KCB = KCHB(KA,KB)
      IF(KCB.LE.0) GO TO 850
      PHI(KCA,KCB,IFR) = COSP(KA,KB)+PHI(KCA,KCB,IFR)
      PHIBL(KCA,KCB,IFR)=COSP(KA,KB)*BLOCK+PHIBL(KCA,KCB,IFR)
      PHISQ(KCA,KCB,IFR)=COSP(KA,KB)*COSP(KA,KB)+PHISQ(KCA,KCB,IFR)
      COSP(KA,KB) = 0.0
      IF(KCA.EQ.KCB) GO TO 850
      PHI(KCB,KCA,IFR)=QUSP(KA,KB)+PHI(KCB,KCA,IFR)
      PHIBL(KCB,KCA,IFR)=QUSP(KA,KB)*BLOCK+PHIBL(KCB,KCA,IFR)
      PHISQ(KCB,KCA,IFR)=QUSP(KA,KB)*QUSP(KA,KB)+PHISQ(KCB,KCA,IFR)
      QUSP(KA,KB) = 0.0
850   CONTINUE
      IFR = IFR+1
      IF (IFR.GT.MAXIF) GO TO 1000
191   ISUB = (IH-1)*(1+(2*KCHAN))
      THARM = IHARM
      IF(.NOT.(THARM.EQ.TAPRAY(ISUB+1))) GO TO 4800
195   DO 980 KA = 1,ICMAX
      KCA = KCHA(KA)
      IF(KCA.LE.0) GO TO 980
      IS = ISUB +(2*KCA)
      IF(INDOW.GT.0) GO TO 196
      ARL = TAPRAY(IS)
      AMG = TAPRAY(IS+1)
      GO TO 199
```

```
196   AR3(KA) = AR2(KA)
      AR2(KA) = AR1(KA)
      AR1(KA) = TAPRAY(IS)
      AM3(KA) = AM2(KA)
      AM2(KA) = AM1(KA)
      AM1(KA) = TAPRAY(IS+1)
      IF(IHARM2.EQ.0) GO TO 197
      IF(IHARM2.LT.NSTART) GO TO 199
      ARL = CORNB*((2.0*AR2(KA))-AR1(KA)-AR3(KA))
      AMG = CORNB*((2.0*AM2(KA))-AM1(KA)-AM3(KA))
      GO TO 199
197   ARL = 2.0*CORNB*(AR2(KA)-AR1(KA))
      AMG = 0.0
199   CONTINUE
      DO 970 KB = 1,ICMAX
      KCB = KCHB(KA,KB)
      IF(KCB.LE.0) GO TO 970
      IT = ISUB+(2*KCB)
      IF(INDOW.GT.0) GO TO 206
      BRL = TAPRAY(IT)
      BMG = TAPRAY(IT+1)
      GO TO 209
206   BR3(KA,KB) = BR2(KA,KB)
      BR2(KA,KB) = BR1(KA,KB)
      BR1(KA,KB) = TAPRAY(IT)
      BM3(KA,KB) = BM2(KA,KB)
      BM2(KA,KB) = BM1(KA,KB)
      BM1(KA,KB) = TAPRAY(IT+1)
      IF(IHARM2.EQ.0) GO TO 207
      IF(IHARM2.LT.NSTART) GO TO 209
      BRL = CORNB*((2.0*BR2(KA,KB))-BR1(KA,KB)-BR3(KA,KB))
      BMG = CORNB*((2.0*BM2(KA,KB))-BM1(KA,KB)-BM3(KA,KB))
      GO TO 209
207   BRL = 2.0*CORNB*(BR2(KA,KB)-BR1(KA,KB))
      BMG = 0.0
209   CONTINUE
      CO =((ARL*BRL)+(AMG*BMG))/2.0
      QU =((BRL*AMG)-(ARL*BMG) )/2.0
C STORE REAL PARTS
      IF(IHARM2.NE.0) GO TO 801
      IF(KCA.EQ.KCB) GO TO 250
      DC(KCA,KCB) = ARL*BRL+DC(KCA,KCB)
      DCSQ(KCA,KCB) = 4.00*CO*CO + DCSQ(KCA,KCB)
      DCBL(KCA,KCB) = ARL*BRL*BLOCK + DCBL(KCA,KCB)
      GO TO 256
250   DC(KCA,KCB) = ARL+DC(KCA,KCB)
      DCSQ(KCA,KCB) = ARL*ARL+DCSQ(KCA,KCB)
      DCBL(KCA,KCB) = (ARL*BLOCK) + DCBL(KCA,KCB)
```

```
256    CONTINUE
801    IF(IHARM2.LT.NSTART) GO TO 970
       COSP(KA,KB) = CO + COSP(KA,KB)
       QUSP(KA,KB) = QU + QUSP(KA,KB)
970    CONTINUE
980    CONTINUE
       IF (IHARM2.EQ.NEND(MAXIF)) GO TO 19005
990    CONTINUE
1000   CONTINUE
       KBLOCK = KBLOCK + 1
       IF(KBLOCK.GT.IBMAX) GO TO 1110
       READ (3,END=1100) ARTAPE
       GO TO 180
C IF END OF FILE, PROCEEDS WITH COMPUTATICN
 1100  IFILE = IFILE + 1
       KBEGIN = 1
       IBMAX = KBLCCK - 1
       WRITE (6,1105) IBMAX
       GO TO 1110
 1108  IFILE = IFILE + 1
       KBEGIN = 1
       IBMAX = KBLCCK
       WRITE (6,1109) IBMAX,NCAR
 1110  BLMAX = IBMAX
       BLROCT = SQRT(BLMAX)
C DATA IS ALL STORED, NOW CONVERT FOR STATISTICS AND WRITE OUT
       IF( IPHASE.EQ.0 ) GO TO 1120
       CALL PHASES( 1,Z,CO,QU,IFB,FREQ,NEND,BANDW,PHASE,KCA,KCB,FUNDFR,
     1 ICMAX,MCHAN, MAXIF, RAD , KCHA)
1120   DO 1130 KA = 1,ICMAX
       KCA = KCHA(KA)
       IF(KCA.LE.0) GO TO 1130
       DO 1130 KB = 1,ICMAX
       KCB = KCHB(KA,KB)
       IF(KCB.LE.0) GO TO 1130
       DDC = DC(KCA,KCB) / BLMAX
       DDCSQ = (DCSQ(KCA,KCB)-(BLMAX*DDC*DDC))/(BLMAX-1.)
       DDCSQ = ABS(DDCSQ)
       IF(KCA.NE.KCB) DDCSQ = SQRT(DDCSQ)
       DCOR = (DCBL(KCA,KCB)-(BL*DDC))/(BLSQ-((BL*BL)/BLMAX))
       DC(KCA,KCB) = DDC
       DCSQ(KCA,KCB) = DDCSQ
       DCBL(KCA,KCB) = DCOR
1130   CONTINUE
       DO 3000 KA = 1,ICMAX
       KCA = KCHA(KA)
       IF (KCA.LE.0) GO TO 3000
       DO 2900 KB = 1,ICMAX
```

```
      KCB = KCHB(KA,KB)
      IF (KCB.LE.0) GO TO 2900
      SUMCO = 0.0
      SUMQU = 0.0
      IF (KCB-KCA) 1200,1150,1200
C WRITE HEADING FCR SPECTRUM
1150  WRITE(6,1155) IDUSER,MCHAN(KCA),(ACHNAM(L,KCA),L=1,9)
      WRITE(6,1165) IBMAX,IBLOCK,SAMFRQ,BLKLNG
      IF(IHANN.GT.0) WRITE(6,14)
      IF(INDOW.GT.0) WRITE(6,194)
      WRITE(6,1175)CAL(KCA),(AUNITS(KL,KCA),KL=1,2),(AUNITS(KL,KCA),
     1 KL=1,2)
      GO TO 1209
C WRITE HEADING FCR COSPECTRUM
1200  WRITE(6,1205) IDUSER,MCHAN(KCA),(ACHNAM(L,KCA),L=1,9),MCHAN(KCB),
     2 (ACHNAM(L,KCB),L=1,9)
      WRITE(6,1165) IBMAX,IBLOCK,SAMFRQ,BLKLNG
      IF(IHANN.GT.0) WRITE(6,14)
      IF(INDOW.GT.0) WRITE(6,194)
      WRITE(6,1206)CAL(KCA),CAL(KCB),(AUNITS(KL,KCA),KL=1,2),
     1(AUNITS(KL,KCB),KL=1,2),(AUNITS(KL,KCA),KL=1,2)
     2,(AUNITS(KL,KCB),KL=1,2),(AUNITS(KL,KCA),KL=1,2),
     3 (AUNITS(KL,KCB),KL=1,2)
C NOW GET AV.DENSITY, STD.DEV.,REGRESSION COEFF
1209  DO 1500 IFB=1,MAXIF
      VID = BANDW(IFB)
      DIV = BLMAX*VID
C FIRST FOR REAL PARTS
      CO = PHI(KCA,KCB,IFB)/DIV
      FCO = CO*FREQ(IFB)
      COSQ =((PHISQ(KCA,KCB,IFB)/(VID*VID))-(BLMAX*CO*CO))/(BLMAX-1.)
      COSQ = ABS(COSQ)
      COSQ = SQRT(COSQ)
      A(IFB)=CO
      AD(IFB) = CO +(COSQ/BLROOT)
      AE(IFB) = CO - (COSQ/BLROOT)
      IF(IPLOT.NE.4) GO TO 12091
      A(IFB) = A(IFB)*FREQ(IFB)
      AD(IFB) = AD(IFB)*FREQ(IFB)
      AE(IFB) = AE(IFB)*FREQ(IFB)
12091 CONTINUE
      COR=((PHIBL(KCA,KCB,IFB)/VID)-(BL*CO))/(BLSQ-((BL*BL)/BLMAX))
C IF THIS WAS SPECTRUM, WRITE OUT
      IF(KCA.EQ.KCB) GO TO 1300
C IF NOT, DO IMAGINARY PARTS
      QU = PHI(KCB,KCA,IFB)/DIV
      QUSQ =((PHISQ(KCB,KCA,IFB)/(VID*VID))-(BLMAX*QU*QU))/(BLMAX-1.)
      QUSQ =ABS(QUSQ)
```

```
      QUSQ = SQRT(QUSQ)
      QUR=((PHIBL(KCB,KCA,IFB)/VID)-(BL*QU))/(BLSQ-((BL*BL)/BLMAX))
      ARL = PHI(KCA,KCA,IFB)/DIV
      BRL = PHI(KCB,KCB,IFB)/DIV
      C = CO * CO
      D = QU*QU
      RAD = SQRT(C+D)
      ARL = ARL*BRL
      ARL = ABS(ARL)
      CORCOF = RAD/SQRT(ARL)
      IF( IPHASE.EQ.0 ) GO TO 1211
      CALL PHASES( 2,Z,CO,QU,IFB,FREQ,NEND,BANDW,PHASE,KCA,KCB,FUNDFR,
     1 ICMAX,MCHAN, MAXIF, RAD , KCHA)
1211  ARG = QU/CO
      FQU = QU*FREQ(IFB)
      FCO = CO*FREQ(IFB)
      A(IFB)=CO
      AD(IFB) = CO +(COSQ/BLROOT)
      AE(IFB) = CO - (COSQ/BLROOT)
      B(IFB) = QU
      BD(IFB) = QU + (QUSQ/BLROOT)
      BE(IFB) = QU - (QUSQ/BLROOT)
      IF(IPLOT.LT.4) GO TO 12092
       IF(IPLOT.GT.4) GO TO 12093
      A(IFB) = A(IFB)*FREQ(IFB)
      AD(IFB) = AD(IFB)*FREQ(IFB)
      AE(IFB) = AE(IFB)*FREQ(IFB)
      B(IFB) = B(IFB)*FREQ(IFB)
      BD(IFB) = BD(IFB)*FREQ(IFB)
      BE(IFB) = BE(IFB)*FREQ(IFB)
      GO TO 12092
12093  A(IFB) = CORCOF
      AD(IFB) = CORCOF
      AE(IFB) = CORCOF
      B(IFB) = BMG
      BD(IFB) = BMG
      BE(IFB) = BMG
12092 CONTINUE
      IF(ARG.LT.10000.) GO TO 1210
      BMG = SIGN(1.,QU)*90.0
      GO TO 1212
1210  BMG = 57.296 * ATAN2(QU,CO)
C WRITE OUT CROSS SPECTRA
1212  WRITE(6,1215)IFB,FREQ(IFB),CO,CCSQ,COR,QU,QUSQ,QUR,FCO,FQU,BMG,
     1 CORCOF
      GO TO 1499
1300  WRITE(6,1305)IFB,FREQ(IFB),BANDW(IFB),CO,COSQ,COR,FCO,NEND(IFB)
1499  SUMCO = SUMCO+(CO*VID)
```

```
      SUMQU = SUMQU + (QU*VID)
1500  CONTINUE
      IF(KCA.EQ.KCB) GO TO 1501
      WRITE(6,1535)SUMCO,(AUNITS(KL,KCA),KL=1,2),(AUNITS(KL,KCB),KL=1,2)
     1,SUMQU,(AUNITS(KL,KCA),KL=1,2),(AUNITS(KL,KCB),KL=1,2)
      GO TO 1502
1501  WRITE(6,1545) SUMCO,(AUNITS(KL,KCA),KL=1,2)
1502   CONTINUE
      IF(KCA.EQ.KCB) GO TO 1503
      DCDIF = DC(KCA,KCB)-(DC(KCA,KCA)*DC(KCB,KCB))
      WRITE(6,1525)DC(KCA,KCB),(AUNITS(KL,KCA),KL=1,2),(AUNITS(KL,KCB),
     1KL=1,2),DCSQ(KCA,KCB),(AUNITS(KL,KCA),KL=1,2),(AUNITS(KL,KCB),KL=
     2 1,2),DCBL(KCA,KCB),(AUNITS(KL,KCA),KL=1,2),(AUNITS(KL,KCB),KL=1,
     3 2),DCDIF,(AUNITS(KL,KCA),KL=1,2),(AUNITS(KL,KCB),KL=1,2)
      GO TO 1504
1503  WRITE(6,1526)DC(KCA,KCB),(AUNITS(KL,KCA),KL=1,2),DCSQ(KCA,KCB),
     1 (AUNITS(KL,KCA),KL=1,2),DCBL(KCA,KCB),(AUNITS(KL,KCA),KL=1,2)
1504   CONTINUE
      IF (IPLOT.EQ.0) GO TC 2900
      LPL = 1
      GO TO (1740,1740,1750,1750,1740,1740,1750,1750),IPLCT
1740   IF(LINOCT) 1770,1770,1750
1750   IF(POS(1).NE.0.0) GO TO 17505
      POSL(1) = POSL(1)+POS(2)-POS(1)
      POSU(1) = POSU(1)+POS(2)-POS(1)
      POS(1) = POS(2)
17505 IF(IFRSCL.GT.0) GO TO 1770
      DO 1751 IL=1,MAXIF
      POSU(IL) = ALOG10(POSU(IL))
      IF(POSL(IL).LE.0.0)POSL(IL) = 0.001*POS(IL)
      POSL(IL) = ALOG10(POSL(IL))
1751   POS(IL) = ALOG10(POS(IL))
1770  GO TO (7100,7001,7001,7100,7100,7001,7001,7100       ) , IPLOT
7001  IF(IPLOT.LE.4) GO TO 70015
      IF(KCA.NE.KCB) GO TO 7100
70015  DO 7003 IL = 1,MAXIF
      IF(A(IL) )8200,8100,8110
8100  A(IL) = AD(IL)
8110  IF(AE(IL).LE.0.0) AE(IL) = A(IL)
      GO TO 8300
8200   A(IL) = -A(IL)
      AE(IL) =-AE(IL)
      AD(IL) = -AD(IL)
      IF (AD(IL) .LE.0.0) AD(IL) = A(IL)
8300  A(IL) = ALOG10(A(IL))
      AD(IL) = ALOG10(AD(IL))
      AE(IL) = ALOG10(AE(IL))
      IF (KCA.EQ.KCB) GO TO 7003
```

```
      IF (B(IL)) 8500,8400,8400
8400  IF(BE(IL).LT.0.0) BE(IL) = B(IL)
      GO TO 8600
8500  B(IL) = -B(IL)
      BE(IL) = -BE(IL)
      BD(IL) = -BD(IL)
      IF (BD(IL).LE.0.0) BD(IL) = B(IL)
8600  B(IL) = ALOG10(B(IL))
      BD(IL) = ALOG10(BD(IL))
      BE(IL) = ALOG10(BE(IL))
7003  CONTINUE
7100  XMIN1 = XRES1
      DX1 = DXRES1
      XMIN2 = XRES2
      DX2 = DXRES2
      ISCL = IAXIS
      IF(IPLOT.GT.4.AND.KCA.NE.KCB) ISCL = 0
      IF(ISCL.GT.0) GO TO 7102
      CALL SCALE(A,MAXIF,5.00,XMIN1,DX1,1)
7102   CONTINUE
      DO 7005 IL = 1,MAXIF
      IF(ISCL.GT.0)A(IL)=(A(IL)-XMIN1)/DX1
      AD(IL) = (AD(IL)-XMIN1)/DX1
      AE(IL) = (AE(IL) - XMIN1)/DX1
      IF(A(IL).GT.6.50) A(IL) = 6.50
      IF(A(IL).LT.0.0)A(IL) = 0.0
      IF(AD(IL).GT.6.50)AD(IL) = 6.50
      IF(AD(IL).LT.0.0) AD(IL) = 0.0
      IF(AE(IL).GT.6.50)AE(IL) = 6.50
      IF(AE(IL).LT.0.00) AE(IL) = 0.00
7005  CONTINUE
      IF (KCA.EQ.KCB) GO TO 7110
      IF(ISCL.GT.0) GO TO 7104
      CALL SCALE(B,MAXIF,5.00,XMIN2,DX2,1)
7104  CONTINUE
      DO 7105 IL = 1,MAXIF
      IF(ISCL.GT.0) B(IL) = (B(IL)-XMIN2)/DX2
      BD(IL) = (BD(IL) - XMIN2)/DX2
      BE(IL) = (BE(IL)-XMIN2)/DX2
      IF(B(IL) .GT.6.50) B(IL) = 6.50
      IF(B(IL).LT.0.0) B(IL)=0.0
      IF(BD(IL).GT.6.50) BD(IL)=6.50
      IF(BD(IL).LT.0.0) BD(IL) = 0.0
      IF(BE(IL).GT.6.50) BE(IL) = 6.50
      IF(BE(IL).LT.0.0) BE(IL) = 0.0
7105  CONTINUE
7110  KC = KCA
      ADDY = 0.0
```

```
7112  DO 7113 ID = 1,9
      ADDX = ID-1
      XS = 2.00+(0.48*ADDX)
      YS = 2.75 - ADDY
      CALL SYMBOL(XS,YS,0.14,ACHNAM(ID,KC),0.00,4)
7113  CONTINUE
      IF (KC .EQ.KCB) GO TO 7120
      KC = KCB
      ADDY = 0.25
      GO TO 7112
 7120 IF(IFRSCL.GT.0) GO TO 7122
      IFRSCL=1
      IF(IAXIS.GT.0) GO TO 7121
      CALL SCALE(POS,MAXIF,4.00,XMIN3,DX3,1)
7121  DO 71215 KIF=1,MAXIF
      IF(IAXIS.NE.0) POS(KIF) =(PCS(KIF)-XMIN3)/DX3
      POSU(KIF) = (POSU(KIF)-XMIN3)/DX3
      POSL(KIF) = (POSL(KIF)-XMIN3)/DX3
      IF(POS(KIF).GT.FRAXLN) POS(KIF) = FRAXLN
      IF(PCS(KIF).LT.0.0) POS(KIF)= 0.0
      IF(POSU(KIF).GT.FRAXLN) POSU(KIF)=FRAXLN
      IF(POSU(KIF).LT.0.0) POSU(KIF)= 0.0
      IF(POSL(KIF).GT.FRAXLN) POSL(KIF) = FRAXLN
      IF(POSL(KIF).LT.0.0) POSL(KIF) = 0.0
71215  CONTINUE
7122  IF(LINOCT.EQ.1) GO TO 71225
      GO TO (7130,7130,71225,71225,7130,7130,71225,71225       ),IPLOT
71225 CALL AXIS(2.00,3.50,15HLOG10 FREQUENCY,-15,FRAXLN,0.0,XMIN3,DX3)
      GO TO 7140
7130  CALL AXIS(2.00,3.50,9HFREQUENCY,-9,FRAXLN,0.0,XMIN3,DX3)
7140  IF(KCA.EQ.KCB) GO TO 7300
      IF (LPL.GT.1) GO TO 7170
      GO TO (7150,7145,7145,7142,7155,7155,7155,7155       ),IPLOT
7142  CALL AXIS(2.00,3.50,       13H FREQ X COSP  ,+19,5.00,90.0,XMIN1,
     1 DX1)
      GO TO 7180
7145   CONTINUE
      CALL AXIS(2.00,3.50,17HLOG10 CO-SPECTRUM,+17,5.00,90.0,XMIN1,
     1 DX1)
      GO TO 7180
7150  CALL AXIS(2.00,3.50,11HCO-SPECTRUM,+11,5.00,90.0,XMIN1,DX1)
      GO TO 7180
7155  CALL AXIS(2.00,3.50,9HCOHERENCE,+9,5.00,90.0,XMIN1,DX1)
      GO TO 7180
7170  GO TO (7175,7171,7171,71715,7172,7172,7172,7172      ),IPLOT
71715 CALL AXIS(2.00,3.50,       13H FREQ X QUSP  ,+19,5.00,90.0,XMIN2 ,
     1 DX2   )
      GO TO 7180
```

```
7171   CONTINUE
      CALL AXIS(2.00,3.50,19HLOG10 QUAD-SPECTRUM,+19,5.00,90.0,XMIN2,
     1 DX2)
      GO TO 7180
7175  CALL AXIS(2.00,3.50,13HQUAD-SPECTRUM,+13,5.00,90.0,XMIN2,DX2)
      GO TO 7180
7172   CALL AXIS(2.00,3.50,5HPHASE,+5,5.00,90.0,XMIN2,DX2)
7180  IF(IPLOT.GE.4) GO TO 7181
      CALL LABEL(AUNITS(1,KCA),AUNITS(1,KCB),2)
7181   CONTINUE
      IF (LPL.GT.1) GO TO 7190
      CALL PLVAL(A,AD,AE,POS,POSU,POSL,MAXIF)
      LPL = 2
      CALL PLOT (0.,YREORG,-3)
      GO TO 7110
7190  CALL PLVAL(B,BD,BE,POS,POSU,POSL,MAXIF)
      LPL = 1
      GO TO 2800
7300  GO TO (7310,7305,7305,7302,7310,7305,7305,7302        ),IPLOT
7302  CALL AXIS(2.00,3.50,       14H FREQ X SPECT    ,+20,5.00,90.0,XMIN1,
     1   DX1   )
      GO TO 7320
7305   CONTINUE
      CALL AXIS(2.00,3.50,14HLOG10 SPECTRUM,+14,5.00,90.0,XMIN1,DX1)
      GO TO 7320
7310  CALL AXIS(2.00,3.50,8HSPECTRUM,+8,5.00,90.0,XMIN1,DX1)
7320  IF(IPLOT.EQ.4.OR.IPLOT.EQ.8) GO TO 7327
      CALL LABEL(AUNITS(1,KCA),AUNITS(1,KCA),1)
7327  CALL PLVAL(A,AD,AE,POS,POSU,POSL,MAXIF)
 2800 CALL PLOT (0.,YREORG,-3)
2900  CONTINUE
3000  CONTINUE
      GO TO 5000
4700  WRITE (6,4705) MBLOCK,IBSTAR,IBMAX,IFILE
      GO TO 5000
4800  WRITE (6,4805) IHARM,TAPRAY(ISUB+1), NT, IH, KCHAN
      GO TO 5000
4900  WRITE (6,4905) IFILE,IDUSER,IDTEST
5000  GO TO 1
5020  IF (LOPT.LE.0) GO TO 5015
      CALL PLOTE
5015   REWIND 3
      CALL EXIT
5     FORMAT(7F10.0)
    6 FORMAT (18A4)
14    FORMAT(45H0 FOURIER COEFFICIENTS WERE HANNED BY FTOR    /)
15    FORMAT (I9,1X,6(I5,5X))
16    FORMAT(I5,2F10.0,I5)
```

```
25     FORMAT (I5,5X,10I5)
62     FORMAT (45H1 SPECTRUM AND CROSS SPECTRUM STATISTICS FOR ,I9/ 2X,
      110HFROM FILE ,I3,5H FOR ,I2,17H CHANNELS, USING ,I3,27H BLOCKS, ST
      2ARTING WITH NO. ,I3/)
194    FORMAT(77H0 FOURIER COEFFICIENTS WERE HANNED BY THIS PROGRAM BEFOR
      1E SPECTRA COMPUTED          /          )
1105   FORMAT(31H0 END OF FILE ENCOUNTERED AFTER,I4, 7H BLOCKS/ 2X
      143HANALYSIS WILL PROCEED WITH DATA READ SO FAR )
1109    FORMAT(34H0 END OF FILE ENCOUNTERED IN BLOCK ,I4,8H, RECORD ,I4/
      1 2X,27HWILL PROCEED WITH ANALYSIS   )
1155   FORMAT(26H1 SPECTRUM STATISTICS FOR ,I9, 8H CHANNEL,I3, 2X,9A4 )
1165   FORMAT (2X,24HSTATISTICS ARE BASED ON ,I3,10H BLOCKS OF ,I5,13H SA
      1MPLES EACH /2X,27HTHE SAMPLING FREQUENCY WAS ,F10.4,35HSAMP/SEC ,
      2MAKING THE BLOCK LENGTH ,F10.5,8H SECONDS /2X,72HTREND IS THE AVER
      3AGE OF (VALUE(A)-VALUE(B))/(BLOCK NO.(A)-BLOCK NO.(B)) )
1175   FORMAT (2X,24HA CALIBRATION FACTOR OF ,1PE10.3,75H HAS BEEN APPLIE
      2D TO THE INPUT DATA                                           ///
      311X,9HFREQUENCY,4X,9HBANDWIDTH,7X,8HSPECTRUM,5X,8HSTD.DEV.,6X,
      4 5HTREND,5X,13HFREQ*SPECTRUM,3X,13HLAST HARMONIC/19X,5HHERTZ,21X,
      5 1H(,2A4,10H)**2/HERTZ   ,13X,1H(,2A4,4H)**2    /)
1205   FORMAT (32H1 CROSS-SPECTRUM STATISTICS FOR ,I9/ 2X,18H BETWEEN CHA
      1NNELS ,I5,9A4/16X,4HAND ,I5,9A4 )
1206   FORMAT(2X,49HPHASE POSITIVE MEANS SECOND CHANNEL LAGS FIRST
      1      / 2X,23HCALIBRATION FACTORS OF , 1PE10.3, 5H AND ,1PE10.3,
      246H HAVE BEEN APPLIED TO THE INPUT DATA            /// 7X,9HFREQUEN
      3CY,2X,11HCO-SPECTRUM,3X,8HSTD.DEV.,4X,5HTREND,4X,13HQUAD-SPECTRUM,
      4 1X,8HSTD.DEV.,4X,5HTREND,6X,7HFREQ*CO,5X,7HFREQ*QU,3X,5HPHASE,3X,
      5 9HCOHERENCE /9X,5HHERTZ,2(7X,1H(,2A4,1H*,2A4,7H)/HERTZ   ),
      6 11X,2A4,1H*,2A4,8X,7HDEGREES   )
1215   FORMAT(2X,I2,3X,1PE9.2,2(4X,1PE9.2,2(2X,1PE9.2)),2(3X,1PE9.2),
      2 3X,0PF7.2,3X,F6.3   )
1305   FORMAT(2X,I3,2(5X,1PE10.2,3X,1PE10.2),3X,1PE10.3,5X,1PE10.3,5X,I6)
1525   FORMAT(45H CORRELATION FORMED FROM ZEROTH HARMONICS HAD   /10X,
      1 11H AVERAGE = ,1PE9.2,2A4,1H*,2A4/10X,11H STD.DEV. =   ,1PE9.2,
      2 2A4,1H*,2A4/10X,9H TREND =     ,1PE9.2,2A4,1H*,2A4/6X,65H(AVERAGE A
      3BOVE) - (PRODUCT OF AVERAGES FOR CHANNELS CONCERNED) =   ,1PE9.2,
      4 2A4,1H*2A4   )
1526   FORMAT(26H ZEROTH HARMONIC (DC) HAD   /10X,11H AVERAGE =  ,1PE9.2,
      1 1X,2A4/9X,12H VARIANCE =   ,1PE9.2,1X,2A4,3H**2 /10X,9H TREND =    ,
      2 1PE9.2,1X,2A4   )
1535   FORMAT(35H INTEGRAL (SUM) UNDER COSPECTRUM =   ,1PE9.2,2X,2A4,1H*,
      1 2A4,/16X,25HAND UNDER QUADSPECTRUM =   ,1PE9.2,2X,2A4,1H*,2A4 )
1545   FORMAT(33H INTEGRAL (SUM) UNDER SPECTRUM =   ,1PE9.2,2X,2A4,3H**2)
4705   FORMAT (36H0 NUMBER OF FIRST BLOCK IS TOO LARGE /2X, 9HMBLOCK = 8
      1 I3,10H IBSTAR = ,I3, 9H IBMAX = ,I3,12H FILE NO. = ,I3 )
4805   FORMAT (41H0 HARMONIC NUMBERS DO NOT MATCH, IHARM = ,I5,17H TAPRAY
      1 NUMBER = , 1PE10.3 /2X,6H NT = ,I5,6H IH = ,I5,9H KCHAN = ,I5 )
4905   FORMAT ( 9H0 IN FILE ,I3,10H IDUSER =,I9,16H BUT YOU WANTED ,I9 )
```

```
5005  FORMAT (37HO RUN TERMINATED IN AN ORDERLY MANNER )
      CONTINUE
      END


      SUBROUTINE PLVAL(A,AD,AE,POS,POSU,POSL,NVAL)
C   SPLOT = PLVAL AND LABEL
C  AUGUST 6 1968                                            JOHN GARRETT
      DIMENSION A(1),AE(1),AD(1),POS(1),POSU(1),POSL(1)
      DO 20 K = 1,NVAL
      Y = A(K) + 3.50
      X = POS(K) + 2.00
      XP = POSL(K) +2.00
      CALL PLCT(XP,Y,+3)
      XP = POSU(K) + 2.00
      CALL PLOT (XP,Y,+2)
      Y = AD(K) + 3.50
      CALL PLOT(X,Y,+3)
      CALL TIC(X,Y)
      Y = AE(K) + 3.50
      CALL PLOT (X,Y,+2)
      CALL TIC(X,Y)
20     CCNTINUE
      RETURN
      END


      SUBROUTINE TIC(X,Y)
      X = X+0.02
      CALL PLOT(X,Y,+2)
      X = X-0.04
      CALL PLOT(X,Y,+2)
      X = X+0.02
      CALL PLOT(X,Y,+2)
      RETURN
      END
```

```
      SUBROUTINE LABEL (U1,U2,ISY)
C VERSION OF APRIL 26 1968
C                                                                JOHN GARRETT
      DIMENSION U1(2),U2(2)
        X = 1.70
       Y = 7.30
      HT = 0.14
       CALL SYMBOL(X,Y,HT,1H(,90.0,1)
        Y = Y+0.12
       CALL SYMBOL(X,Y,HT,U1,90.0,8)
        Y = Y+1.00
      GO TO (10,20), ISY
20     CALL SYMBOL(X,Y,HT,1HX,90.0,1)
        Y = Y+0.20
        CALL SYMBOL(X,Y,HT,U2,90.0,8)
        Y = Y+0.96
      GO TO 30
10     XSUP = X-0.10
       CALL SYMBOL(XSUP,Y,HT,1H2,90.0,1)
       Y = Y+0.18
30      CALL SYMBOL(X,Y,HT,7H/HERTZ),90.0,7)
      RETURN
      END


      SUBROUTINE PHASES(N,A,CO,QU,IFB,F,ND,BW,PHASE,KCA,KCB,FFR,ICM,
     1 MCHAN, MAXIF, RAD, KCHA )
C                                                               FRED DOBSON
      DIMENSION A(1),F(1),ND(1),BW(1),MCHAN(1),PHASE(50,1),PHCOR(50,11),
     1 SUMP(12), MWR(10), KCHA(1)
      KTRL = N + 1
      GO TO ( 10,100,500 ) , KTRL
10    DO 9800 MZERO = 1,48
      DO 9800 NZERO = 1,11
      PHCOR( MZERO,NZERO ) = 0.0
9800  CONTINUE
      MFRE = 0
      DO 9820 KARD = 1,6
      READ( 5,9825 ) ( PHASE(JFRE,1), JFRE = 1,8 )
      DO 9820 LFRE = 1,8
      MFRE = MFRE + 1
      FIN = PHASE( LFRE,1 )
      IF( FIN.EQ.0.) GO TO 9830
      PHCOR( MFRE,1 ) = FIN
9820  CONTINUE
      NFR = 48
```

```
      GO TO 9835
9830  NFR = MFRE - 1
9835  MCH = ICM + 1
      DO 9840 NCHS = 2,MCH
      MCOR = 0
      DO 9840 KRD = 1,KARD
      READ( 5,9825 ) ( PHASE(JFRE,NCHS), JFRE = 1,8 )
      DO 9840 LCOR = 1,8
      MCOR = MCOR + 1
      PHCOR( MCOR,NCHS ) = PHASE( LCOR,NCHS )
9840  CONTINUE
      RETURN
100   NPH = 1
      DO 450 I = 1,MAXIF
      DO 110 LS = 1,12
      SUMP(LS) = 0.
110   CONTINUE
      ANIB = BW(I)/FFR
      NIB = ANIB + 0.000001
      IF( NIB.EQ.0 ) NIB = 1
      PHASE(I,1) = F(I)
      B = ND(I) -NIB
      DO 400 J = 1,NIB
      D = J
      C = B + D
      FR = C*FFR
120   FRS = PHCOR(NPH,1 )
      IF(FRS.GT.FR)  GO TO 400
      NPL = NPH + 1
      IF( NPL.GT.NFR ) GO TO 460
      FRL = PHCOR( NPL,1 )
      IF( FR.GT.FRL ) GO TO 130
      GO TO 140
130   NPH = NPH + 1
      GO TO 120
140   FRD = FRL - FRS
      FDIF = FR - FRS
      FRFR = FDIF/FRD
      DO 390 M = 2,MCH
      PHIL = PHCOR(NPL,M)
      PHIS = PHCOR(NPH,M)
      PHID = PHIL - PHIS
390   SUMP(M) = SUMP(M) + PHIS + PHID*FRFR
400   CONTINUE
      IF(ANIB.EQ.0. ) ANIB = 1.
      DO 450 MP = 2,MCH
      PHASE( I,MP ) = SUMP( MP )/(ANIB)
450   CONTINUE
```

```
      GO TO 600
460   IAD = I
      DO 480 IZ = IAD,MAXIF
      PHASE(IZ,1) = F(IZ)
      DO 480 MZ = 2,MCH
      PHASE(IZ,MZ ) = 0.
480   CONTINUE
      WRITE( 6,55 )
600   DO 490 K = 1,10
      KY = KCHA(K)
      IF(KY.EQ.0 ) GO TO 495
      MWR(K) = MCHAN(KY)
      GO TO 490
495   MWR(K) = 0
490   CONTINUE
      WRITE(6,10904) (MWR(KCS),KCS = 1,10 )
      DO 50 IWR = 1,NFR
      WRITE( 6,10915 ) ( PHCOR(IWR,JWR ), JWR = 1,MCH )
50    CONTINUE
      WRITE( 6,10905 ) ( MWR(KCS),KCS = 1,10 )
      DO 601   IRO = 1, MAXIF
      WRITE (6,10915) (PHASE(IRO,JCO), JCO = 1,MCH )
601   CONTINUE
      RETURN
500   ARG = QU/CO
      KDA = KCA + 1
      KDB = KCB + 1
      PHICOR = PHASE( IFB,KDA ) - PHASE( IFB,KDB )
      IF( ARG.GT.10000. ) GO TO 9300
      BNG = ATAN2( QU,CO ) + PHICOR
      GO TO 9400
9300  BNG = (1.5708)*SIGN(1.,QU) + PHICOR
9400  TB = TAN( BNG )
      SB = SIN( BNG )
      QU = RAD*SB
      CO = RAD*SB/TB
      RETURN
55    FORMAT(1H0,93H FREQUENCIES ENCOUNTERED WHICH ARE GREATER THAN HIGH
     1EST AVAILABLE PHASE CORRECTION FREQUENCY./57H  CORRECTIONS ABOVE T
     2HAT FREQUENCY HAVE BEEN SET TO ZERO.  )
9825  FORMAT( 8F10.4 )
10904 FORMAT(1H0,52X,26HPHASE CORRECTIONS ON CARDS //1X, 10HFREQ.(HZ.) ,
     15X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,
     25X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2/)
10905 FORMAT(1H0,50X,28HPHASE CORRECTIONS IN RADIANS//1X,10HFREQ.(HZ.),
     15X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,
     25X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2,5X,4HCH. ,I2/)
10915 FORMAT( 1X, 1PE10.2, 9( 3X, 0PF8.4 ))
```

```
      END
C
C     THIS SUBROUTINE WHEN CALLED MOVES THE TAPE ON LOGICAL UNIT NUNIT
C     PAST KSKIP END OF FILE MARKS. THE RECORDS SKIPPED OVER MUST BE IN
C     FORTRAN BINARY. IF KSKIP IS ZERO OR NEGATIVE THE ROUTINE RETURNS
C     WITHOUT MOVING THE TAPE.
C

      SUBROUTINE SKPFL (KSKIP,NUNIT)
      IF (KSKIP.LT.1) RETURN
      DO 20 I=1,KSKIP
   10 READ (NUNIT,END=20) IDUMMY
      GO TO 10
   20 CONTINUE
      RETURN
      END


      SUBROUTINE SCALE (X,N,S,YMIN,DY,K)                                SCAL0020
      DIMENSION X(2)                                                    SCAL0030
       LOGICAL FLAG                                                     SCAL0034
       FLAG = .FALSE.                                                   SCAL0036
      YMAX=X(1)                                                         SCAL0040
      YMIN=YMAX                                                         SCAL0050
      NP=N*K                                                            SCAL0060
      DO 10 I=1,NP,K                                                    SCAL0070
      IF(YMAX-X(I)) 5,6,6                                               SCAL0080
    5 YMAX=X(I)                                                         SCAL0090
    6 IF(X(I)-YMIN) 7,10,10                                             SCAL0100
    7 YMIN=X(I)                                                         SCAL0110
   10 CONTINUE                                                          SCAL0120
105   RANGE = YMAX - YMIN                                               SCAL0130
      IF(RANGE.NE.0.0) GO TO 11                                         SCAL0140
      DY = 0.0                                                          SCAL0150
      DO 12 I = 1,NP,K                                                  SCAL0160
   12 X(I) = 0.0                                                        SCAL0170
      RETURN                                                            SCAL0180
   11 SFACT = RANGE / (S )                                              SCAL0190
       SFLOG = ALOG10(SFACT)                                            SCAL0200
      IF(SFLOG.GE.0.0) GO TO 13                                         SCAL0210
       SFLOG =  SFLOG - 1.                                              SCAL0220
   13 ISFLOG = SFLOG                                                    SCAL0230
      SFACT  = SFACT / 10.** ISFLOG                                     SCAL0240
```

```
      IF(SFACT.GT.1.0) GO TO 14                                         SCAL0250
      DY = 10.** ISFLOG                                                 SCAL0260
      GO TO 15                                                          SCAL0270
   14 IF(SFACT.GT.2.0) GO TO 16                                         SCAL0280
      DY = 2. * 10.** ISFLOG                                            SCAL0290
      GO TO 15                                                          SCAL0300
   16 IF(SFACT.GT.4.0) GO TO 17                                         SCAL0310
      DY = 4. * 10.** ISFLOG                                            SCAL0320
      GO TO 15                                                          SCAL0330
   17 IF(SFACT.GT.5.0) GO TO 18                                         SCAL0340
      DY = 5. * 10.** ISFLOG                                            SCAL0350
      GO TO 15                                                          SCAL0360
   18 IF(SFACT.GT.8.0) GO TO 19                                         SCAL0370
      DY = 8.0 * 10.** ISFLOG                                           SCAL0380
      GO TO 15                                                          SCAL0390
   19 DY = 10.**(ISFLOG + 1)                                            SCAL0400
15    TEMP = YMIN / DY                                                  SCAL0410
       IF( FLAG ) GO TO 21                                              SCAL0415
      IF(TEMP.LT.0.) TEMP = TEMP - 1.0                                  SCAL0420
      IYMIN = TEMP                                                      SCAL0430
      YMIN = FLOAT(IYMIN)* DY                                           SCAL0440
       FLAG = .TRUE.                                                    SCAL0444
       TEMP = YMIN + S * DY                                             SCAL0446
C      SCALE AGAIN IF THE RANGE HAS INCREASED TOO MUCH                  SCAL0447
       IF( YMAX .GT. TEMP ) GO TO 105                                   SCAL0448
21    DO 20 I=1,NP,K                                                    SCAL0450
   20 X(I)=(X(I)-YMIN)/DY                                               SCAL0460
      RETURN                                                            SCAL0470
      END                                                               SCAL0480


      SUBROUTINE AXIS(X,Y,BCD,NC,SIZE,THETA,YMIN,DY)
       DIMENSION BCD( 2 )
      SIG = 1.0
      IF( NC ) 1 , 2 , 2
1     SIG = -1.0
2     NAC = IABS( NC )
      TH = THETA * 0.017453294
      N = SIZE + 0.5
      TN = N
      CTH = COS( TH )
      STH = SIN( TH )
C**** SCALE THE AXIS *****
      ADY = DY
      ABSU = YMIN
      EXP = 0.0
```

```
      IF( ADY ) 9, 18, 9
9     IF( ABS( ADY ) - 100.0 ) 10 , 12 , 12
12    ADY =  ADY * 0.1
      ABSU =  ABSU * 0.1
      EXP = EXP + 1.0
      GO TO 9
14    ADY = ADY * 10.0
      ABSU = ABSU * 10.0
      EXP = EXP - 1.0
10    IF( ABS( ADY ) - 0.01 )  14 , 18 , 18
C$**** INITIALIZE THE MAIN LOOP *****
C      XL , YL  ETC. ARE FOR THE LINE
C     XN , YN  ETC. ARE FOR THE NUMBERS
C     XT , YT  ETC. ARE FOR THE TITLE
C$****
18    XS = X
      YS = Y
      TEMP =  0.2*SIG - 0.05
      XNA = XS - TEMP*STH - 0.0857*CTH
      YNA = YS + TEMP*CTH - 0.0857*STH
       NAFT = 3
       ICK = ABS( ABSU) * 1000.0 + 0.5
       IF( MOD( ICK , 10 ) .EQ. 0 ) NAFT = 2
       IF( MOD( ICK , 100 ) .EQ. 0 ) NAFT = 1
      CALL NUMBER( XNA , YNA, 0.10, ABSU, THETA, NAFT )
       XLB = XS + TN * CTH
       YLB = YS + TN * STH
      TEMP = 0.1*SIG
       XLA = XLB - TEMP * STH
       YLA = YLB + TEMP * CTH
      NBY2 = N/2
C$**** THIS IS THE MAIN LOOP *****
      DO 20 I = 1 , N
C$**** NEXT THE NUMBER *****
      XNA = XNA +CTH
      YNA = YNA +STH
      ABSU = ABSU + ADY
       NAFT = 3
       ICK = ABS( ABSU) * 1000.0 + 0.5
       IF( MOD( ICK , 10 ) .EQ. 0 ) NAFT = 2
       IF( MOD( ICK , 100 ) .EQ. 0 ) NAFT = 1
      CALL NUMBER( XNA , YNA, 0.10, ABSU, THETA, NAFT )
C***** NOW PERHAPS THE TITLE *****
      IF( I .NE. NBY2 ) GO TO19
      TNC = NAC + 7
      TEMP =  SIZE*0.5 -0.06*TNC
      TEMPB=  (-0.07 + SIG*0.36 )
      XT   =  XS + TEMP*CTH  - TEMPB*STH
```

```
      YT    =   YS + TEMP*STH   + TEMPB*CTH
      CALL SYMBOL( XT , YT, 0.14 ,BCD, THETA, NAC )
      IF( EXP .EQ. 0.) GO TO 19
      TEMP = ( TNC - 6.0 )*0.12
      XT = XT + TEMP*CTH
      YT = YT + TEMP*STH
      CALL SYMBOL( XT, YT, 0.14, 7H(X10   ) , THETA, 7 )
      XT = XT   + 0.48*CTH - 0.07*STH
      YT = YT   + 0.48*STH + 0.07*CTH
      CALL NUMBER( XT, YT, 0.10, EXP,  THETA, -1 )
19    CONTINUE
20    CONTINUE
C***** TRACE THE LINE BACKWARDS TO THE ORIGIN *****
       CALL PLOT( XLA , YLA , +3 )
       CALL PLOT( XLB , YLB , +2 )
       DO 44 I = 1 , N
C$**** BOTTOM OF NEXT TIC  *****
       XLB = XLB - CTH
       YLB = YLB - STH
       CALL PLOT( XLB , YLB , +2 )
C$**** TOP OF NEXT TIC *****
       XLA = XLA - CTH
       YLA = YLA - STH
       CALL PLOT( XLA , YLA , +2 )
       CALL PLOT( XLB , YLB , +2 )
44     CONTINUE
      RETURN
      END
```

```
C       PRINTER PLOT OF AMPLITUDE FROM FOURIER COEFFICIENT TAPE
C
C       THE FIRST INPUT CARD SHOULD CONTAIN UP TO 72 CHARACTERS OF PLOT
C       IDENTIFICATION FOR USE BY THE COMPUTING CENTER STAFF AND IS
C       REPRODUCED ON THE PLOTTER OUTPUT. THIS CARD MUST BE PRESENT
C       WHETHER PLOTS ARE PRODUCED OR NOT. IT IS PRESENT ONLY ONCE IN THE
C       DECK. THE FOLLOWING SET OF CARDS IS PRESENT FOR EACH FILE OF
C       FOURIER COEFFICIENTS PROCESSED.
C
C       CONTROL CARD DECK MAKEUP
C
C       1)    KFILE,KCHAN,KSTART,KSTOP,KPLOT,KRULE,KLIST,KPUNCH,LOGLIN,
C             LOGLOG                                                  (10I5)
C
C       WHERE,
C
C             KFILE = NO. OF FILE ON FOURIER COEFFICIENT TAPE
C
C             KCHAN = NO. OF FOURIER COEFFICIENT TAPE CHANNEL DESIRED
C
C             KSTART = FIRST BLOCK TO BE INCLUDED IN ANANYSIS
C
C             KSTOP = LAST BLOCK TO BE INCLUDED IN ANALYSIS
C
C             KPLOT = 1 FOR CALCOMP PLOT
C                   = 0 FOR NO CALCOMP PLOT
C
C             KRULE = 1 FOR A COLUMN OF PERIODS PER INCH ON THE PLOT
C                   = 0 IF THIS IS NOT DESIRED
C
C             KLIST = 1 FOR A PRINTER PLOT
C                   = 0 TO SUPPRESS THE PRINTER PLOT
C
C             KPUNCH = 1 TO PUNCH A BINARY DECK OF THE INTERMEDIATE SUMS
C                    = 0 OTHERWISE
C
C             LOGLIN = 1 TO OBTAIN A LOG VS LINEAR SPECTRUM PLOT
C                    = 0 OTHERWISE
C
C             LOGLOG = 1 TO OBTAIN A LOG LOG SPECTRUM PLOT
C                    = 0 OTHERWISE
C
C       2)    TITLE CARD WITH UP TO 72 COLUMNS OF IDENTIFICATION FOR
C             PRINTER OUTPUT AND PLOTS
C
C       THE FOLLOWING CARD IS PRESENT ONLY IF LOGLIN = 1 ON CARD 1)
C
C       3)    NDCDE,NPDCDE,FSTART,DPINCH                        (2I10,2F10.0)
```

```
C
C     WHERE,
C
C          NDCDE = NO. OF FREQUENCY DECADES TO BE PLOTTED
C
C          NPDCDE = MAXIMUM DESIRED NO. OF SPECTRAL ESTIMATES PER DFCADE
C
C          FSTART = ANOTATICN TO APPEAR ON FIRST FREQUENCY DECADE ON
C                   PLOT
C
C          DPINCH = NO. OF FREQUENCY CECADES TO BE PLCTTED PER INCH
C
C     THE FCLLOWING CARD IS PRESENT ONLY IF LOGLOG = 1 ON CARD 1)
C
C     4)   NDCDE,NPDCDE,FSTART,DPINCH,NYDCDE,DY  (2I10,2F10.0,I10,F10.0)
C
C     WHERE,
C
C          NDCDE = NO. OF FREQUENCY DECADES TO BE PLOTTED
C
C          NPDCDE = MAXIMUM DESIRED NO. OF SPECTRAL ESTIMATES PER DECADE
C
C          FSTART = ANOTATICN TO APPEAR ON FIRST FREQUENCY DECADE ON
C                   PLOT
C
C          DPINCH = NO. OF FREQUENCY CECADES TO BE PLCTTED PER INCH
C
C          NYDCDE = NO. OF DECADES TO BE PLOTTED ON SPECTRAL DENSITY
C                   AXIS
C
C          DY = NO. OF DECADES PER INCH TO BE PLOTTED ON SPECTRAL
C               DENSITY AXIS
C
C
C     INPUT TAPE IS ON LOGICAL UNIT 9
C
C          A BLANK CARD WILL TERMINATE THE RUN OR ANOTHER COMPLETE SET
C     OF CARDS WILL DO A SECOND ANALYSIS
C
C          THE PROGRAM DOES AN ANALYSIS ON THE FOURIER COEFFICIENTS
C     DEFINED BY THE FIRST CONTROL CARD. THE FOURIER COEFFICIENT NO.,
C     ITS FREQUENCY, ITS MEAN AMPLITUDE AND ITS 95 PERCENT CONFIDENCE
C     INTERVAL ARE PRINTED. THE MEAN AND 95 CONFIDENCE INTERVAL ARE
C     PLOTTED ON THE PRINTER. ONLY THE MEAN IS PLOTTED ON THE CALCOMP
C     PLCTTER.
C
C          THE PROGRAM WILL HANDLE ONLY ONE CHANNEL AT A TIME FROM THE
C     FOURIER COEFFICIENT TAPE
```

```
C
      DIMENSION DATA(4098),AMPL(2049),VAR(2049),KPLOT(101),KTITLE(18),AP
     1LOT(3),VAR2(2049),JUNITS(2),JDUMMY(2),GTITLE(18)
      KUNIT = 9
      KMODE = 1
      KPCALL = 0
      NPAGE = 0
      JRCHAN = 1
      REWIND KUNIT
      IFILE = 1
      KBEGIN = 1
      READ (5,2002) GTITLE
    5 READ (5,2001) KFILE,KCHAN,KSTART,KSTOP,KPLOTI,KRULE,KLIST,KPUNCH,L
     1OGLIN,LOGLOG,LPUNCH
      IF (KFILE.LE.0) GO TO 135
      NPAGE = NPAGE + 1
      WRITE (6,4001) NPAGE
      WRITE (6,4002) KFILE,KCHAN,KSTART,KSTOP
      IF (KPLCTI.EQ.1) WRITE (6,4003)
      IF (KLIST.EQ.1) WRITE (6,4011)
      IF (KPUNCH.EQ.1) WRITE (6,4017)
      IF (LOGLIN.EQ.1) WRITE (6,4015)
      IF (LOGLOG.EQ.1) WRITE (6,4016)
      READ (5,2002) (KTITLE(I),I=1,18)
      WRITE (6,4007) (KTITLE(I),I=1,18)
    6 KSKIP = KFILE - IFILE
      IF (KSKIP.GT.0) GO TO 8
      IF (KSKIP.LT.0) GO TO 7
      IF (KBEGIN.EQ.1) GO TO 9
    7 REWIND KUNIT
      IFILE = 1
      KBEGIN = 1
      GO TO 6
    8 CALL SKPFL (KSKIP,KUNIT)
      IFILE = IFILE + KSKIP
      KBEGIN = 1
    9 CALL FCINPT (-KUNIT,IDUSER,KBLOCK,NSAMPL,JRCHAN,KCHAN,DFREQ,JUNITS
     1,DATA,IND)
      IF (IND.EQ.1) GO TO 160
      KSKIP = KSTART - 1
      IF (KSKIP.LE.0) GO TO 15
      DO 10 I=1,KSKIP
      CALL FCINPT (KUNIT,IDUSER,KBLOCK,KSAMPL,JRCHAN,KCHAN,XFREQ,JDUMMY,
     1DATA,IND)
      KBEGIN = 0
      WRITE (6,4018) I
      IF (IND.EQ.1) GO TO 160
   10 CONTINUE
```

```
15 KPTS = (NSAMPL + 2)/2
   IF (KPTS.GT.2049) GO TO 170
   DO 20 I=1,KPTS
   AMPL(I) = 0.
   VAR(I) = 0.
20 VAR2(I) = 0.
   LBLOCK = 0
   DO 30 I=KSTART,KSTOP
   CALL FCINPT (KUNIT,IDUSER,KBLOCK,KSAMPL,JRCHAN,KCHAN,XFREQ,JDUMMY,
  1DATA,IND)
   KBEGIN = 0
   WRITE (6,4019) I
   IF (IND.EQ.1) GO TO 180
   LBLOCK = LBLOCK + 1
   DO 30 J=1,KPTS
   A = DATA (2*J-1)
   B = DATA(2*J)
   X = A*A + B*B
   AMPL(J) = AMPL(J) + SQRT(X)
   VAR(J) = VAR(J) + X
30 VAR2(J) = VAR2(J) + X*X
40 WRITE (6,4009) LBLOCK
   IF (KPUNCH.EQ.0) GO TO 45
   WRITE (7,2002) KPTS,LBLOCK
   WRITE (7,2002) (AMPL(J),J=1,KPTS)
   WRITE (7,2002) (VAR(J),J=1,KPTS)
   WRITE (7,2002) (VAR2(J),J=1,KPTS)
45 XBLOCK = LBLOCK
   DO 50 J=1,KPTS
   AMPL(J) = AMPL(J)/XBLCCK
   VAR(J) = VAR(J)/XBLOCK
50 VAR2(J) = VAR2(J)/XBLOCK
   IF (KPCALL.EQ.1) GO TO 52
   IF (LOGLIN.EQ.0.AND.LOGLOG.EQ.0) GO TO 55
   CALL PLOTS
   CALL SYMBOL (0.,0.,0.14,GTITLE,0.,72)
   CALL PLOT (0.,3.,-3)
   KPCALL = 1
52 IF (LOGLIN.EQ.1) CALL LOGPLT (FLCAT(NSAMPL),DFREQ,VAR(2),VAR2(2),X
  1BLOCK,KTITLE,MOFLOW)
   IF (LCGLOG.EQ.1) CALL LLPLOT (FLOAT(NSAMPL),DFREQ,VAR(2),VAR2(2),X
  1BLOCK,KTITLE,MOFLOW,LPUNCH)
55 DO 56 J=1,KPTS
56 VAR(J) = 1.96*SQRT((VAR(J) - AMPL(J)*AMPL(J))/(XBLOCK - 1.))
   CALL SCALE (AMPL(2),KPTS-1,10.,XMIN,DX,1)
   WRITE (6,4014) AMPL(1),JUNITS(1),JUNITS(2),VAR(1),JUNITS(1),JUNITS
  1(2)
   IF (KLIST.EQ.0) GO TO 132
```

```
      CALL REPLCE (KPERD,1H.)
      CALL REPLCE (KRECMK,1H )
      CALL REPLCE (KAST,1H*)
      CALL REPLCE (KMINUS,1H-)
      CALL REPLCE (KBLANK,1H )
      XSAMPL = NSAMPL
      XMAX = 10.*DX + XMIN
      WRITE (6,4010) XMIN,(JUNITS(K),K=1,2),XMAX,(JUNITS(K),K=1,2),DX,(J
     1UNITS(K),K=1,2)
      KPAGE = 0
      CALL GRHEAD (100,KPAGE)
      DO 130 I=2,KPTS
      NCOEFF = I - 1
      FREQ = NCOEFF
      FREQ = FREQ*DFREQ/XSAMPL
      XAMPL = AMPL(I)*DX + XMIN
      XVAR = VAR(I)
      SVAR = VAR(I)/DX
      APLOT(1) = AMPL(I) - SVAR
      APLOT(2) = AMPL(I)
      APLOT(3) = AMPL(I) + SVAR
      KMIN = 10.*APLOT(1) + 1.5
      KPOINT = 10.*APLOT(2) + 1.5
      KMAX = 10.*APLOT(3) + 1.5
      KERRP = KBLANK
      IF (KMIN.LT.1.OR.KMAX.GT.101) KERRP = KRECMK
      KI = KMIN + 1
      KF = KMAX - 1
      IF (KI.LT.1) KI = 1
      IF (KF.GT.101) KF = 101
      DO 60 INDEX=1,101
   60 KPLOT(INDEX) = KBLANK
      KPLOT(1) = KPERD
      KPLOT(101) = KPERD
      IF (KRULE.EQ.0) GO TO 80
      LS = ((KF-1)/10 + 1)*10 + 1
      IF (LS.GT.91) GO TO 80
      DO 70 INDEX = LS,101,10
   70 KPLOT(INDEX) = KPERD
   80 IF (KI.GT.KF) GO TO 100
      DO 90 INDEX=KI,KF
   90 KPLOT(INDEX) = KMINUS
  100 IF (KMIN.GT.0) KPLOT(KMIN) = KAST
      KPLOT(KPOINT) = KAST
      IF (KMAX.LT.102) KPLOT(KMAX) = KAST
      WRITE (6,4004) NCOEFF,FREQ,XAMPL,XVAR,KERRP,(KPLOT(K),K=1,101)
  130 CALL GRHEAD (1,KPAGE)
  132 IF (KPLOTI.EQ.1) GO TO 140
```

```
      GO TO 5
  135 REWIND KUNIT
      IF (KPCALL.EQ.1) CALL PLOT (0.,3.,-3)
      IF (KPCALL.EQ.1) CALL PLOTE
      WRITE (6,4005)
      WRITE (6,4006)
      CALL EXIT
  140 IF (KPCALL.EQ.1) GO TO 145
      CALL PLOTS
      CALL SYMBOL (C.,0.,0.14,GTITLE,0.,72)
      CALL PLOT (0.,3.,-3)
      KPCALL = 1
  145 S = KPTS/100 + 1
      IF (S.GT.9.) S = 9.
      IF (LOGLOG.EQ.1.OR.LOGLIN.EQ.1) CALL PLOT (0.,2.,-3)
      CALL AXIS (0.,0.,19HFOURIER COEFFICIENT,-19,S,0.,0.,100.)
      CALL AXIS (0.,0.,9HAMPLITUDE,9,10.,90.,XMIN,DX)
      CALL SYMBOL (0.,10.1,0.14,KTITLE,0.,72)
      KGPTS = KPTS
      IF (KGPTS.GT.900) KGPTS = 9[illegible]
      IPEN = 3
      DO 150 I=2,KGPTS
      X = I - 1
      X = 0.01*X
      CALL PLOT (X,AMPL(I),IPEN)
  150 IPEN = 2
      CALL PLOT (0.,14.,-3)
      GO TO 5
  160 WRITE (6,4008)
      GO TO 5
  170 WRITE (6,4012)
      GO TO 5
  180 IFILE = IFILE + 1
      KBEGIN = 1
      GO TO 40
 2001 FORMAT (11I5)
 2002 FORMAT (18A4)
 4001 FORMAT (58H1AVERAGED AMPLITUDE SPECTRUM FROM FOURIER COEFFICIENT T
     1APE,65X,4HPAGE,I3)
 4002 FORMAT (9H0FILE NO.,I3/15H A TO D CHANNEL,I3/27H ANALYSIS STARTS W
     1ITH BLOCK,I5,20H AND ENDS WITH BLOCK,I5)
 4003 FORMAT (28H0A CALCOMP PLOT IS REQUESTED)
 4004 FORMAT (I5,F8.2,1PE9.2,E8.1,102A1)
 4005 FORMAT (11H0END OF JOB)
 4006 FORMAT (1H1)
 4007 FORMAT (1H0,18A4)
 4008 FORMAT (45H0UNEXPECTED END OF FILE WHILE SPACING FORWARD)
 4009 FORMAT (1H0,I5,16H BLOCKS ANALYSED)
```

```
4010 FORMAT (25H0PRINTER PLOT DEFINITIONS//4H 0 =,1PE10.3,1H ,2A4/6H 10
    10 =,E10.3,1H ,2A4/9H 1 INCH =,E10.3,1H ,2A4/)
4011 FORMAT (28H0A PRINTER PLOT IS REQUESTED)
4012 FORMAT (52H0THE MAXIMUM TRANSFORM SIZE (4096) HAS BEEN EXCEEDED)
4014 FORMAT (18H0MEAN OF SERIES IS,1PE11.3,1H ,2A4//60H 95 PER CENT CON
    1FIDENCE INTERVAL ABOUT MEAN IS PLUS OR MINUS,E11.3,1H ,2A4/)
4015 FORMAT (34H0A LOG VS LINEAR PLOT IS REQUESTED)
4016 FORMAT (28H0A LOG LOG PLOT IS REQUESTED)
4017 FORMAT ('0AN EBCD DECK OF SUMMED COEFFICIENTS IS REQUESTED')
4018 FORMAT (18H SKIPPING IN BLOCK,I4)
4019 FORMAT (20H PROCESSING IN BLOCK,I4)
     END


     SUBROUTINE LLPLOT (XSAMPL,DFREQ,DATA,VAR,XBLOCK,NXANOT,MOFLOW,LPUN
    1CH)
     DIMENSION DATA(1),VAR(1),Y(100),NC(100),NXANOT(1)
     INTEGER YERROR
     READ (5,2001) NDCDE,NPDCDE,FSTART,CPINCH,NYDCDE,DY
     WRITE (6,4001) (NXANOT(K),K=1,18)
     MOFLOW = 0
     FACTR = DFREQ/XSAMPL
     HBAND = 0.5*FACTR
     NCMAX = IFIX(XSAMPL)/2
     XDECDE = ALOG10(XSAMPL*FACTR/(2.*HBAND) + 1.)
     NPTS = XDECDE*FLOAT(NPDCDE) + 0.5
     FLINCR = XDECDE/FLOAT(NPTS)
     I = 1
     ISTART = 1
     NXTMIN = 0
     FBASE = ALOG10(HBAND)
     DO 30 K=1,NPTS
     NCOEFF = (10.**(FBASE + FLINCR*FLOAT(K)))/FACTR + 0.5
     IF (NCOEFF.LT.ISTART) GO TO 30
     IF (NCOEFF.LT.NXTMIN) NCOEFF = NXTMIN
     IF (I.GT.100) GO TO 60
     NC(I) = NCOEFF
     Y(I) = 0.
     DO 10 J=ISTART,NCOEFF
  10 Y(I) = Y(I) + DATA(J)
     Y(I) = Y(I)/(2.*FLOAT(NCOEFF-ISTART+1)*FACTR)
     NXTMIN = 2*NCOEFF - ISTART + 1
     IF (NXTMIN.GT.NCMAX) NXTMIN = NCMAX
     ISTART = NCOEFF + 1
     I = I + 1
  30 CONTINUE
```

```
      NPTS = I - 1
      S = FLOAT(NDCDE)/DPINCH
      CALL AXIS (0.,2.,13HLCG FREQUENCY,-13,S,0.,FSTART,DPINCH)
      DENMAX = 0.
      DO 32 I=1,NPTS
   32 IF (DENMAX.LT.Y(I)) DENMAX = Y(I)
      YLMAX = ALOG10(DENMAX)
      IF (YLMAX.LT.0.) GO TO 34
      YLMAX = FLOAT(IFIX(YLMAX + 1.))
      GO TO 36
   34 YLMAX = FLOAT(IFIX(YLMAX))
   36 YMIN = YLMAX - FLOAT(NYDCDE)
      YULMT = 10.**YLMAX
      YLLMT = 10.**YMIN
      YLNG = FLCAT(NYDCDE)/DY
      CALL AXIS (0.,2.,23HLCG OF SPECTRAL DENSITY,23,YLNG,90.,YMIN,DY)
      CALL SYMBOL (0.,YLNG + 2.5,0.14,NXANOT,0.,72)
      ISTART = 1
      DO 50 I=1,NPTS
      NCOEFF = NC(I)
      FRLOW = FLCAT(ISTART)*FACTR - HBAND
      FRHIGH = FLOAT(NCOEFF)*FACTR + HBAND
      BANDW = FRHIGH - FRLOW
      FRMID = (FRHIGH + FRLCW)/2.
      XPOS = (ALOG10(FRMID) - FSTART)/DPINCH
      YERROR = 0.
      IF (Y(I).LT.YLLMT) GO TO 70
      YPOS = (ALOG10(Y(I)) - YMIN)/DY + 2.
      CALL PLOT (XPCS,YPOS,3)
      CALL PLOT ((ALOG10(FRLOW) - FSTART)/DPINCH,YPOS,2)
      CALL PLOT ((ALOG10(FRHIGH) - FSTART)/DPINCH,YPOS,2)
      CALL PLCT (XPOS,YPOS,2)
      YVAR = 0.
      DO 40 K=ISTART,NCOEFF
   40 YVAR = YVAR + VAR(K)
      YVAR = 1.96*SQRT((YVAR/(4.*BANDW*FACTR) - Y(I)*Y(I))/(FLOAT(NCOEFF
     1-ISTART+1)*XBLOCK - 1.))
      YUPPER = Y(I) + YVAR
      IF (YUPPER.GT.YULMT) GO TO 80
      CALL PLOT (XPOS,(ALOG10(YUPPER)-YMIN)/DY+2.,2)
      CALL HORTIC
   42 YLOWER = Y(I) - YVAR
      IF (YLOWER.LT.YLLMT) GO TO 90
      CALL PLOT (XPOS,(ALOG10(YLOWER)-YMIN)/DY+2.,2)
      CALL HORTIC
   44 IF (YERROR.EQ.0) WRITE (6,4002) I,ISTART,NCOEFF,FRMID,BANDW,Y(I),Y
     1VAR
      IF (YERROR.EQ.1) WRITE (6,4004) I,ISTART,NCOEFF,FRMID,BANDW,Y(I),Y
```

```
     1VAR
      IF (LPUNCH.EQ.1) WRITE (7,4002) I,ISTART,NCOEFF,FRMID,BANDW,Y(I),Y
     1VAR
   46 IF (YERROR.EQ.1) CALL SYMBOL (XPOS+0.03,1.,0.07,1HX,0.,1)
   50 ISTART = NCOEFF + 1
      CALL PLOT (0.,YLNG+3.,-3)
      RETURN
   60 MOFLOW = 1
      WRITE (6,4003)
      RETURN
   70 YERROR = 1
      GO TO 44
   80 YERROR = 1
      CALL PLOT (XPOS,YLNG+2.,2)
      GO TO 42
   90 YERROR = 1
      CALL PLOT (XPOS,2.,2)
      GO TO 44
 2001 FORMAT (2I10,2F10.0,I10,F10.0)
 4001 FORMAT (55H1LOG FREQUENCY VS LOG SPECTRAL DENSITY PLOT INFORMATION
     1//1H ,18A4//80H POINT  START   STOP   MID FREQUENCY    BANDWIDTH
     2  SPEC. DENSITY     95 CONFID.)
 4002 FORMAT (1H ,I4,I8,I7,1P4E15.4)
 4003 FORMAT (40H0TOO MANY POINTS REQUESTED. PLOT SKIPPED)
 4004 FORMAT (1H ,I4,I8,I7,1P4E15.4,10X,21HPLOTTER PEN OFF SCALE)
      END


      SUBROUTINE LOGPLT (XSAMPL,DFREQ,CATA,VAR,XBLOCK,NXANOT,MOFLOW)
      DIMENSION DATA(1),VAR(1),Y(100),NC(100),YMEAN(100),NXANOT(1)
      READ (5,2001) NDCDE,NPDCDE,FSTART,DPINCH
      WRITE (6,4001) (NXANOT(K),K=1,18)
      MOFLOW = 0
      FACTR = DFREQ/XSAMPL
      HBAND = 0.5*FACTR
      NCMAX = IFIX(XSAMPL)/2
      XDECDE = ALOG10(XSAMPL*FACTR/(2.*HBAND) + 1.)
      NPTS = XDECDE*FLOAT(NPDCDE) + 0.5
      FLINCR = XDECDE/FLOAT(NPTS)
      I = 1
      ISTART = 1
      NXTMIN = 0
      FBASE = ALOG10(HBAND)
      DO 30 K=1,NPTS
      NCOEFF = (10.**(FBASE + FLINCR*FLOAT(K)))/FACTR + 0.5
      IF (NCOEFF.LT.ISTART) GO TO 30
```

```
      IF (NCOEFF.LT.NXTMIN) NCOEFF = NXTMIN
      IF (I.GT.100) GO TO 60
      NC(I) = NCOEFF
      Y(I) = 0.
      DO 10 J=ISTART,NCOEFF
   10 Y(I) = Y(I) + DATA(J)
      Y(I) = Y(I)/(2.*FLOAT(NCOEFF-ISTART+1)*FACTR)
      YMEAN(I) = Y(I)
      NXTMIN = 2*NCOEFF - ISTART + 1
      IF (NXTMIN.GT.NCMAX) NXTMIN = NCMAX
      ISTART = NCOEFF + 1
      I = I + 1
   30 CONTINUE
      NPTS = I - 1
      S = FLOAT(NCCDE)/DPINCH
      CALL AXIS (0.,2.,13HLCG FREQUENCY,-13,S,0.,FSTART,DPINCH)
      CALL SCALE (Y,NPTS,6.,YMIN,DY,1)
      CALL AXIS (0.,2.,27HSPECTRAL DENSITY - MV**2/HZ,27,6.,90.,YMIN,DY)
      CALL SYMBOL (0.,8.5,0.14,NXANOT,0.,72)
      ISTART = 1
      DO 50 I=1,NPTS
      NCOEFF = NC(I)
      FRLOW = FLOAT(ISTART)*FACTR - HBAND
      FRHIGH = FLCAT(NCOEFF)*FACTR + HBAND
      BANDW = FRHIGH - FRLOW
      FRMID = (FRHIGH + FRLOW)/2.
      XPOS = (ALOG10(FRMID) - FSTART)/DPINCH
      YPOS = Y(I) + 2.
      CALL PLCT (XPCS,YPOS,3)
      CALL PLOT ((ALOG10(FRLOW) - FSTART)/DPINCH,YPOS,2)
      CALL PLOT ((ALOG10(FRHIGH) - FSTART)/DPINCH,YPOS,2)
      CALL PLOT (XPOS,YPOS,2)
      YVAR = 0.
      DO 40 K=ISTART,NCOEFF
   40 YVAR = YVAR + VAR(K)
      YVAR = 1.96*SQRT((YVAR/(4.*BANDW*FACTR)-YMEAN(I)*YMEAN(I))/(FLOAT(
     1NCOEFF-ISTART+1)*XBLOCK-1.))
      IERTIC = 0
      JERTIC = 0
      YPOS = (YMEAN(I) + YVAR - YMIN)/DY + 2.
      IF (YPOS.LE.8.) GO TO 42
      YPOS = 8.
      IERTIC = 1
   42 CALL PLOT (XPOS,YPOS,2)
      IF (IERTIC.EQ.0) CALL HORTIC
      YPOS = (YMEAN(I) - YVAR - YMIN)/DY + 2.
      IF (YPOS.GE.2.) GO TO 44
      YPOS = 2.
```

```
      JERTIC = 1
   44 CALL PLOT (XPCS,YPOS,2)
      IF (JERTIC.EQ.0) CALL HORTIC
      IF (IERTIC.EQ.1.OR.JERTIC.EQ.1) GO TO 46
      WRITE (6,4002) I,ISTART,NCOEFF,FRMID,BANDW,YMEAN(I),YVAR
      GO TO 50
   46 WRITE (6,4004) I,ISTART,NCOEFF,FRMID,BANDW,YMEAN(I),YVAR
      CALL SYMBOL (XPOS+0.03,1.,0.07,1HX,1)
   50 ISTART = NCOEFF + 1
      CALL PLOT (0.,9.,-3)
      RETURN
   60 MOFLOW = 1
      WRITE (6,4003)
      RETURN
 2001 FORMAT (2I10,2F10.0)
 4001 FORMAT (41H1LOG FREQUENCY VS LINEAR PLOT INFORMATION,//1H ,18A4//8
     10H POINT  START    STOP    MID FREQUENCY     BANDWIDTH     SPEC. DENSI
     2TY     95 CONFID./)
 4002 FORMAT (1H ,I4,I8,I7,1P4E15.4)
 4003 FORMAT (40HOTOO MANY POINTS REQUESTED. PLOT SKIPPED)
 4004 FORMAT (1H ,I4,I8,I7,1P4E15.4,10X,21HPLOTTER PEN OFF SCALE)
      END


      SUBROUTINE GRHEAD (INCRMT,NPAGE)
      DATA LNCTR/0/
      LNCTR = LNCTR + INCRMT
      IF (LNCTR.LE.57) RETURN
      IF (NPAGE.NE.0) WRITE (6,4001) (I,I=10,100,10)
      NPAGE = NPAGE + 1
      WRITE (6,4002) (I,I=10,100,10)
      LNCTR = 1
      RETURN
 4001 FORMAT (1H ,30X,9H0........,I2,8(8H........,I2),7H.......,I3)
 4002 FORMAT (31H1COEF    FREQ      AMPL     95 C   ,9H0........,I2,8(8H....
     1....,I2),7H.......,I3)
      END
C     FOURIER COEFFICIENT INPUT SUBROUTINE
C
C          THIS SUBPROGRAM RETRIEVES BLOCKS OF FOURIER COEFFICIENTS FROM
C     THE TAPE PRODUCED BY THE FTOR PROGRAM. FOR EACH CALL ONE GROUP OF
C     K BLOCKS OF N/2 + 1 COEFFICIENTS WILL BE RETURNED IN AN ARRAY.
C
C     WHERE,
C
C     K = NO. OF CHANNELS TO BE RETURNED FROM THE FTOR TAPE AND N = NO.
```

```
C      OF DATA PCINTS IN EACH FOURIER TRANSFORM
C
C      CALLING SEQUENCE
C
C      CALL FCINPT (NUNIT,IDUSER,KBLOCK,NSAMPL,JRCHAN,LCHN,DFREQ,JUNITS,A
C     1,IND)
C
C      WHERE,
C
C           NUNIT = NO. OF TAPE UNIT CONTAINING THE COCEAN TAPE
C
C           IDUSER = 9 DIGIT USER IDENTIFICATION NUMBER (RETURNED)
C
C           KBLOCK = CONSECUTIVE NUMBER OF BLCCK OF COEFFICIENTS ON THE
C           COCEAN TAPE (RETURNED)
C
C           NSAMPL = NO. CF POINTS IN THE FOURIER TRANSFORM (RETURNED)
C
C           JRCHAN = NO. CF TRANSFORMEC CHANNELS TO BE RFTURNED
C
C           LCHN = FIRST LOCATION OF AN ARRAY CONTAINING THE LOCATIONS OF
C           THE JRCHAN CHANNELS TO BE RETURNED
C
C           DFREQ = FREQUENCY FO'DIGITAL DATA TRANSFORMED (RETURNED)
C
C           JUNITS = 8 CHARACTER NAMES OF UNITS OF DATA (RETURNED)
C
C           A = ARRAY INTO WHICH COEFFICIENTS ARE TO BE RETURNED
C
C           IND = 0 FOR NORMAL RETURN
C               =1 FOR END OF INPUT FILE
C
C      IF THE CALLING SEQUENCE
C
C      CALL FCINPT (-NUNIT,IDUSER,KBLOCK,NSAMPL,JRCHAN,LCHN,DFREQ,A,IND)
C
C      IS EXECUTED, TITLE INFORMATION ABOUT THE TAPE WILL BE PRINTED AND
C      ALL INFORMATION EXCEPT THE VECTOR A WILL BE RETURNED
C
C           THE ADDRESS OF THE FIRST COEFFICIENT FOR EACH CF THE JRCHAN
C      TRANSFORMS RETURNED WILL BE GIVEN BY (NSAMPL+2)*(KCHAN-1) + 1
C      WHERE KCHAN = NO. OF CHANNEL REQUIRED
C
```

```
      SUBROUTINE FCINPT (NUNIT,IDUSER,KBLOCK,NSAMPL,JRCHAN,LCHN,DFREQ,JU
     1NITS,A,IND)
      DIMENSION MTAPE(256),ATAPE(256),A(1),LCHN(1),JUNITS(1)
      EQUIVALENCE (MTAPE(1),ATAPE(1))
      KUNIT = IABS(NUNIT)
      READ (KUNIT,END=70) MTAPE
      IF (NUNIT.LT.0) GO TO 50
      IDUSER = MTAPE(1)
      KBLOCK = MTAPE(2)
      NSAMPL = MTAPE(3)
      DFREQ = ATAPE(6)
      IND = 0
      READ (KUNIT,END=70) MTAPE
      K = 1
      DO 30 N=1,NCOEFF
      NOLOC = 2*N - 1
      IF (K.LE.NCRSEQ) GO TO 10
      READ (KUNIT,END=70) MTAPE
      K = 1
   10 NILOC = K*KINCR + KOFF
      DO 20 J=1,JRCHAN
      JOLOC = (J-1)*JINCR + NOLOC
      JILOC = NILCC + 2*LCHN(J)
      A(JOLCC) = ATAPE(JILOC)
   20 A(JOLCC+1) = ATAPE(JILOC+1)
   30 K = K + 1
      RETURN
   50 IDUSER = MTAPE(1)
      KBLOCK = MTAPE(2)
      NSAMPL = MTAPE(3)
      DFREQ = ATAPE(6)
      IND = 0
      NCOEFF = MTAPE(3)/2 + 1
      JCHANS = MTAPE(5)
      DO 55 I=1,JRCHAN
      J = LCHN(I)
      JUNITS(2*I-1) = MTAPE(2*J+119)
   55 JUNITS(2*I) = MTAPE(2*J+120)
      KINCR = 2*JCHANS + 1
      KOFF = - KINCR
      NCRSEQ = 256/KINCR
      JINCR = 2*NCOEFF
      WRITE (6,4001) IDUSER,MTAPE(3),JCHANS,DFREQ
      WRITE (6,4002)
      DO 60 J=1,JCHANS
      WRITE (6,4003) J,MTAPE(J+10)
      LSTART = 9*J + 22
      LSTOP = LSTART + 8
```

```
      WRITE (6,4004) (MTAPE(K),K=LSTART,LSTOP)
   60 WRITE (6,4005) MTAPE(2*J+119),MTAPE(2*J+120),ATAPE(J+140)
      BACKSPACE KUNIT
      RETURN
   70 IND = 1
      RETURN
 4001 FORMAT (27HOCOCEAN TAPE SPECIFICATIONS/20HOUSER IDENTIFICATION,I10
     1/15H TRANSFORM SIZE,I6/32H NO. OF CHANNELS TRANSFORMED WAS,I3/23H
     2SAMPLING FREQUENCY WAS,F10.4,15H SAMPLES/SECOND)
 4002 FORMAT (20HOCHANNEL INFORMATION/)
 4003 FORMAT (8HOCHANNEL,I3,24H FROM OCEAN TAPE CHANNEL,I3)
 4004 FORMAT (1H ,9A4)
 4005 FORMAT (19H UNITS OF DATA ARE ,2A4/24H CALIBRATION FACTOR WAS ,1PE
     116.7)
      END
C
C     THIS SUBROUTINE DRAWS A HORIZONTAL TIC ON THE PLOT AT THE POSITION
C     OF THE PEN AT THE TIME OF THE CALL. THE TIC IS 0.04 INCHES LONG.
C     THE PEN IS RETURNED TO ITS POSITION AT THE TIME OF THE CALL.
C


      SUBROUTINE HORTIC
      CALL WHERE (X,Y)
      CALL PLOT (X-0.02,Y,2)
      CALL PLOT (X+0.02,Y,2)
      CALL PLOT (X,Y,2)
      RETURN
      END


      SUBROUTINE REPLCE (M,N)
      M = N
      RETURN
      END
C
C     THIS SUBROUTINE WHEN CALLED MOVES THE TAPE ON LOGICAL UNIT NUNIT
C     PAST KSKIP END OF FILE MARKS. THE RECORDS SKIPPED OVER MUST BE IN
C     FORTRAN BINARY. IF KSKIP IS ZERO OR NEGATIVE THE ROUTINE RETURNS
C     WITHOUT MOVING THE TAPE.
C
```

```
      SUBROUTINE SKPFL (KSKIP,NUNIT)
      IF (KSKIP.LT.1) RETURN
      DO 20 I=1,KSKIP
   10 READ (NUNIT,END=20) IDUMMY
      GO TO 10
   20 CONTINUE
      RETURN
      END


      SUBROUTINE SCALE (X,N,S,YMIN,DY,K)                                SCAL0020
      DIMENSION X(2)                                                    SCAL0030
       LOGICAL FLAG                                                     SCAL0034
       FLAG = .FALSE.                                                   SCAL0036
      YMAX=X(1)                                                         SCAL0040
      YMIN=YMAX                                                         SCAL0050
      NP=N*K                                                            SCAL0060
      DO 10 I=1,NP,K                                                    SCAL0070
      IF(YMAX-X(I)) 5,6,6                                               SCAL0080
    5 YMAX=X(I)                                                         SCAL0090
    6 IF(X(I)-YMIN) 7,10,10                                             SCAL0100
    7 YMIN=X(I)                                                         SCAL0110
   10 CONTINUE                                                          SCAL0120
105   RANGE = YMAX - YMIN                                               SCAL0130
      IF(RANGE.NE.0.0) GO TO 11                                         SCAL0140
      DY = 0.0                                                          SCAL0150
      DO 12 I = 1,NP,K                                                  SCAL0160
   12 X(I) = 0.0                                                        SCAL0170
      RETURN                                                            SCAL0180
   11 SFACT = RANGE / (S )                                              SCAL0190
       SFLOG = ALOG10(SFACT)                                            SCAL0200
      IF(SFLOG.GE.0.0) GO TO 13                                         SCAL0210
       SFLOG =  SFLOG - 1.                                              SCAL0220
   13 ISFLOG = SFLOG                                                    SCAL0230
      SFACT  = SFACT / 10.** ISFLOG                                     SCAL0240
      IF(SFACT.GT.1.0) GO TO 14                                         SCAL0250
      DY = 10.** ISFLOG                                                 SCAL0260
      GO TO 15                                                          SCAL0270
   14 IF(SFACT.GT.2.0) GO TO 16                                         SCAL0280
      DY = 2. * 10.** ISFLOG                                            SCAL0290
      GO TO 15                                                          SCAL0300
   16 IF(SFACT.GT.4.0) GO TO 17                                         SCAL0310
      DY = 4. * 10.** ISFLOG                                            SCAL0320
      GO TO 15                                                          SCAL0330
   17 IF(SFACT.GT.5.0) GO TO 18                                         SCAL0340
      DY = 5. * 10.** ISFLOG                                            SCAL0350
```

```
      GO TO 15                                                          SCAL0360
   18 IF(SFACT.GT.8.0) GO TO 19                                         SCAL0370
      DY = 8.0 * 10.** ISFLOG                                           SCAL0380
      GO TO 15                                                          SCAL0390
   19 DY = 10.**(ISFLOG + 1)                                            SCAL0400
15    TEMP = YMIN / DY                                                  SCAL0410
       IF( FLAG ) GO TO 21                                              SCAL0415
      IF(TEMP.LT.0.) TEMP = TEMP - 1.0                                  SCAL0420
      IYMIN = TEMP                                                      SCAL0430
      YMIN = FLOAT(IYMIN)* DY                                           SCAL0440
       FLAG = .TRUE.                                                    SCAL0444
       TEMP = YMIN + S * DY                                             SCAL0446
C      SCALE AGAIN IF THE RANGE HAS INCREASED TOO MUCH                  SCAL0447
       IF( YMAX .GT. TEMP ) GO TO 105                                   SCAL0448
21    DO 20 I=1,NP,K                                                    SCAL0450
   20 X(I)=(X(I)-YMIN)/DY                                               SCAL0460
      RETURN                                                            SCAL0470
      END                                                               SCAL0480


      SUBROUTINE AXIS(X,Y,BCD,NC,SIZE,THETA,YMIN,DY)
       DIMENSION BCD( 2 )
      SIG = 1.0
      IF( NC ) 1 , 2 , 2
1     SIG = -1.0
2     NAC = IABS( NC )
      TH = THETA * 0.017453294
      N = SIZE + 0.5
      TN = N
      CTH = COS( TH )
      STH = SIN( TH )
C**** SCALE THE AXIS *****
      ADY = DY
      ABSU = YMIN
      EXP = 0.0
      IF( ADY ) 9, 18, 9
9     IF( ABS( ADY ) - 100.0 ) 10 , 12 , 12
12    ADY =  ADY * 0.1
      ABSU =  ABSU * 0.1
      EXP = EXP + 1.0
      GO TO 9
14    ADY = ADY * 10.0
      ABSU = ABSU * 10.0
      EXP = EXP - 1.0
10    IF( ABS( ADY ) - 0.01 )  14 , 18 , 18
C$**** INITIALIZE THE MAIN LOOP *****
```

```
C       XL , YL  ETC. ARE FOR THE LINE
C      XN , YN  ETC. ARE FOR THE NUMBERS
C      XT , YT  ETC. ARE FOR THE TITLE
C$****
18     XS = X
       YS = Y
       TEMP =  0.2*SIG - 0.05
       XNA = XS - TEMP*STH - 0.0857*CTH
       YNA = YS + TEMP*CTH - 0.0857*STH
        NAFT = 3
        ICK = ABS( ABSU) * 1000.0 + 0.5
        IF( MOD( ICK , 10 ) .EQ. 0 ) NAFT = 2
        IF( MOD( ICK , 100 ) .EQ. 0 ) NAFT = 1
       CALL NUMBER( XNA , YNA, 0.10, ABSU, THETA, NAFT )
        XLB = XS + TN * CTH
        YLB = YS + TN * STH
       TEMP = 0.1*SIG
        XLA = XLB - TEMP * STH
        YLA = YLB + TEMP * CTH
       NBY2 = N/2
C$**** THIS IS THE MAIN LOOP *****
       DO 20 I = 1 , N
C$**** NEXT THE NUMBER *****
       XNA = XNA +CTH
       YNA = YNA +STH
       ABSU = ABSU + ADY
        NAFT = 3
        ICK = ABS( ABSU) * 1000.0 + 0.5
        IF( MOD( ICK , 10 ) .EQ. 0 ) NAFT = 2
        IF( MOD( ICK , 100 ) .EQ. 0 ) NAFT = 1
       CALL NUMBER( XNA , YNA, 0.10, ABSU, THETA, NAFT )
C***** NOW PERHAPS THE TITLE *****
       IF( I .NE. NBY2 ) GO TO19
       TNC = NAC + 7
       TEMP =  SIZE*0.5 -0.06*TNC
       TEMPB=  (-0.07 + SIG*0.36 )
       XT   =  XS + TEMP*CTH  - TEMPB*STH
       YT   =  YS + TEMP*STH  + TEMPB*CTH
       CALL SYMBOL( XT , YT, 0.14 ,BCD, THETA, NAC )
       IF( EXP .EQ. 0.) GO TO 19
       TEMP = ( TNC - 6.0 )*0.12
       XT = XT + TEMP*CTH
       YT = YT + TEMP*STH
       CALL SYMBOL( XT, YT, 0.14, 7H(X10  ) , THETA, 7 )
       XT = XT  + 0.48*CTH - 0.07*STH
       YT = YT  + 0.48*STH + 0.07*CTH
       CALL NUMBER( XT, YT, 0.10, EXP,  THETA, -1 )
19     CONTINUE
```

```
20     CONTINUE
C***** TRACE THE LINE BACKWARDS TO THE ORIGIN *****
        CALL PLOT( XLA , YLA , +3 )
        CALL PLOT( XLB , YLB , +2 )
        DO 44 I = 1 , N
C$**** BOTTOM OF NEXT TIC  *****
        XLB = XLB - CTH
        YLB = YLB - STH
        CALL PLOT( XLB , YLB , +2 )
C$**** TOP OF NEXT TIC *****
        XLA = XLA - CTH
        YLA = YLA - STH
        CALL PLOT( XLA , YLA , +2 )
        CALL PLOT( XLB , YLB , +2 )
44      CONTINUE
       RETURN
       END
```

APPENDIX L

```
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C                                                                      C
C     PROGRAM VECTOR                                                   C
C                                                                      C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C     THIS PROGRAM IS WRITTEN TO PROVIDE A PROGRESSIVE VECTOR DIAGRAM.  THIS
C     DIAGRAM WILL SHOW THE SUMMATION OF VECTORS MADE OF CURRENT SPEED AND
C     CURRENT DIRECTION FOR ONE HOUR PERIODS.  THE VECTORS ARE FOUND FROM THE
C     OUTPUT OF PROGRAM CURRENT.  THESE VALUES ARE TAKEN FROM PROGRAM CURRENT,
C     PUNCHED ONTO COMPUTOR CARDS AND THEN USED IN THE PROGRAM.
C     THE PROGRESSIVE VECTOR DIAGRAM WILL SHOW THE VOLUME TRANSPORT OF WATER AT
C     A GIVEN LOCATION AND DEPTH.  THIS WILL INDICATE WHETHER, AT THIS DEPTH,
C     THERE IS A NET TRANSPORT OF WATER AND WHAT IS THE DIRECTION OF MOVEMENT.
C
C     WRITTEN BY: LT. W.A. CASTER
C     DATE: 4 AUGUST 1969
C
C
      DIMENSION SPD(200),DIR(200),X(200),Y(200),A(200),B(200),XA(200),
     *YB(200)
      REAL*8 TVT
C     N = NUMBER OF DATA POINTS
      READ(5,10) N
   10 FORMAT(I6)
      WRITE(6,11) N
   11 FORMAT (1H1,6X,'NO. OF DATA POINTS = ',I6,///)
      REAL LABEL/4H END/
      REAL*8 ITITLE(12)
      READ(5,20) ITITLE
   20 FORMAT(6A8)
      REAL*8 LABEA/8H        /
C     READ IN DATA.
      READ (5,21) (SPD(I),DIR(I),I = 1,N)
   21 FORMAT (8(F5.2,F4.0))
C     PRINT OUT DATA.
      WRITE (6,12)
   12 FORMAT (7X,'SPEED',3X,'DIRECTION',4X,'DATA PT. NO.',/)
      WRITE(6,13) (SPD(I),DIR(I),I, I = 1,N)
   13 FORMAT (6X,F5.2,6X,F4.0,9X,I4)
C     INITILIZE
      X(1) = 0.
      Y(1) = 0.
      A(1) = 0.
      B(1) = 0.
      N1 = N + 1
      WRITE (6,22)
   22 FORMAT (1H1)
      DO 1 I=2,N1
```

```
C     CONVERT DIRECTION IN DEGREES TO DIRECTION IN RADIANS BY MULTIPLING BY
C     0.01745.
C     CONVERT CURRENT SPEED AND DIRECTION VECTOR INTO X AND Y COMPONENTS.
      X(I) = SPD(I-1)*SIN(DIR(I-1)*0.01745)
      Y(I) = SPD(I-1)*COS(DIR(I-1)*0.01745)
C     A AND B ARE THE SUM OF THE INDIVIDUAL X AND Y VALUES.
      A(I) = X(I) + A(I-1)
      B(I) = Y(I) + B(I-1)
      WRITE(6,23) X(I),Y(I),A(I),B(I)
   23 FORMAT (5X,'X= ',F10.4,5X,'Y= ',F10.4, 5X,'A= ',F10.4,5X,'B= ',
     *F10.4)
    1 CONTINUE
      K = 1
      DO 2 I=1,N1,24
C     XA AND YB WILL BE THE VALUES OF A AND B AT THE END OF A 24 HOUR PERIOD.
      XA(K) = A(I)
      YB(K) = B(I)
      K = K+1
    2 CONTINUE
      N2 = N1/24
C     CALL DRAW WILL DRAW PROGRESSIVE VECTOR DIAGRAMS USING THE CALCOMP PLOTTER
C     IF THE NUMBER OF DATA POINTS ARE LESS THAN 25, THE THE SECOND DRAW
C     STATEMENT SHOULD BE DELETED, BECAUSE THIS STATEMENT INDICATES A 'X' EVERY
C     24 HOURS AND DRAW MUST HAVE AT LEAST TWO POINTS IN ORDER TO DRAW.
      CALL DRAW (N1,A,B,1,0,LABEL,ITITLE,1.,1.,0,0,0,0,9,10,0,LAST)
      CALL DRAW (N2,XA,YB,3,1,LABEA,ITITLE,1.,1.,0,0,0,0,9,10,0,LAST)
      WRITE (6,22)
      CALL PLOTP (X,Y,N1,0)
      WRITE (6,22)
      CALL PLOTP (A,B,N1,1)
      CALL PLOTP (XA,YB,N2,3)
      WRITE (6,24) A(N1),B(N1)
   24 FORMAT (1H1,5X,'FINAL A VALUE= ',F10.4,1X,'N.M.',5X,'FINAL B VALUE
     *= ',F10.4,1X,'N.M.',///)
C     VECTOR SUM IN NAUTICAL MILES.
      VECSUM = SQRT(A(N1)*A(N1)+B(N1)*B(N1))
C     CONVERT TO METERS.
      VECSUM = VECSUM*(1853.248)
      WRITE (6,25) VECSUM
   25 FORMAT (5X,'VECTOR SUM= ',F10.4,1X,'METERS',///)
C     AREA = ONE SQUARE METER
      AREA = 1.0
      WRITE (6,27) AREA
   27 FORMAT (5X,'AREA= ',F10.4,1X,'M**2',///)
C     TOTAL VOLUME TRANSPORT IN M**3.
      TVT = AREA*VECSUM
      WRITE (6,28) TVT
   28 FORMAT (5X,'TOTAL VOLUME TRANSPORT= ',1D20.13,1X,'M**3',///)
```

```
C       VOLUME TRANSPORT PER HOUR.
        AN = N
        XVT = TVT/AN
        WRITE (6,29) XVT
     29 FORMAT (5X,'VOLUME TRANSPORT PER HOUR= ',F20.4,1X,'M**3/HR',///)
        STOP
        END
```

LITERATURE CITED

Batchelor, G.K., "Small-scale Variation of Convected Quantities Like Temperature in Turbulent Fluid. Part 1. General Discussion and the Case of Small Conductivity," Journal of Fluid Mechanics, Vol. 5, Part 1, pp. 113-133, 1959.

Dooley, John J., "An Investigation of Near-Bottom Currents in the Monterey Submarine Canyon," Unpublished Master's Thesis, Naval Postgraduate School, Monterey, California, 1968.

Franz, F., "Model 501 in situ Current Speed, Current Direction, and Temperature Recording System, Operation and Maintenance Instructions," Hydro Products, San Diego, California, 1967.

Gatje, P.H. and Pizinger, D.D., "Bottom Current Measurements in the Head of Monterey Submarine Canyon," Unpublished Master's Thesis, Naval Postgraduate School, Monterey, California, 1965.

Kuenen, P. H., Marine Geology, pp. 485-526, Wiley, 1950.

Martin, Bruce D., "Monterey Submarine Canyon, California: Genesis and Relationship to Continental Geology," Unpublished Ph.D. Thesis, University of Southern California, 1964.

Martin, B. D. and Emery, K.O., "Geology of Monterey Canyon, California," The American Association of Petroleum Geologists Bulletin, Vol. 51, No. 11, pp. 2281-2304, 1967.

Njus, Ingamar J., "An Investigation of Environmental Factors Affecting the Near-Bottom Currents in the Monterey Submarine Canyon," Unpublished Master's Thesis, Naval Postgraduate School, Monterey, California, 1968.

Raines, William A., "Sub-Tidal Oscillations in Monterey Harbor," Unpublished Master's Thesis, Naval Postgraduate School, Monterey, California, 1967.

Robinson, David B., "Seiching in Monterey Bay," Unpublished Master's Thesis, Naval Postgraduate School, Monterey, California, 1969.

Shepard, Francis P., Submarine Geology, 2d ed., Harbor & Row, 1963.

Shepard, F.P., Curray, J.R., Inman, D.L., Murray, E.A., Winterer, E.L. and Dill, R.F., "Submarine Geology by Diving Saucer," Science, Vol. 145, No. 3636, pp. 1042-1045, 1964.

Shepard, F.P. and Emery, K.O., "Submarine Topography Off the California Coast: Canyons...," Geological Society of American Special Papers, No. 31, pp. 72-78, 1941.

Shepard, F.P. and Marshall, N.F., "Currents in La Jolla and Scripps Submarine Canyons," Science, Vol. 165, No. 3891, pp. 177-178, 1969.

Shepard, F.P., Revelle, R.R. and Dietz, R.S., "Ocean Bottom Currents Off the California Coast," Science, Vol. 89, No. 2317, pp. 488-489, 1939.

Skogsberg, Tage, "Hydrography of Monterey Bay, California. Thermal Conditions, 1929-1933," Transactions of the American Philosophical Society, Vol. XXIX, 1936.

Squire, James L., "Observations on Cumulative Bottom Drift in Monterey Bay Using Seabed Drifters," Limnology and Oceanography, Vol. 14, No. 1, pp. 163-167, 1969.

Stetson, H.C., "Current Measurements in the Georges Bank Canyons," Transactions of the American Geophysical Union, Vol. 18, pp. 216-219, 1937.

Veatch, A.C. and Smith, P.A., "Atlantic Submarine Valleys of the United States and the Congo Submarine Valley," Geological Society of America Special Papers Number 7, 1939.

Webster, Ferris, "Some Perils of Measurements from Moored Ocean Buoys," Technical Report No. 64-18, Unpublished Manuscript, Woods Hole Oceanographic Institute, Woods Hole Massachusetts, 1964a.

Webster, F., "Processing Moored Current Meter Data," Technical Report No. 64-55, Unpublished Manuscript, Woods Hole Oceanographic Institute, Woods Hole, Massachusetts, 1964b.

Wilson, J.R., Boston, N.E.J. and Denner, W.W., "Digital Analysis of Turbulence Data on the IBM 360/67 at the Naval Postgraduate School," Unpublished Manuscript, Naval Postgraduate School, Monterey, California, 1969.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	20
2.	Library, Code 0212 Naval Postgraduate School Monterey, California 93940	2
3.	Department of Oceanography, Code 58 Naval Postgraduate School Monterey, California 93940	3
4.	Professor Warren W. Denner, Code 58Dw Naval Postgraduate School Monterey, California 93940	10
5.	Oceanographer of the Navy The Madison Building 732 N. Washington Street Alexandria, Virginia 22314	1
6.	Superintendent U. S. Naval Academy Annapolis, Maryland 21402	1
7.	Commandant (PTP) U. S. Coast Guard Washington, D. C. 20226	2
8.	Commandant (OMS) U. S. Coast Guard Washington, D. C. 20226	1
9.	Commanding Officer U. S. Coast Guard Oceanographic Unit Bldg. 159-E, Navy Yard Annex Washington, D. C. 20390	1
10.	MST School U. S. Coast Guard Training Center U. S. Coast Guard Base Governors Island New York, N. Y. 10004	1
11.	Department of Oceanography U. S. Coast Guard Academy New London, Connecticut 06320	1

12. Commander (oms) 1
Eastern Area, U.S. Coast Guard
U. S. Coast Guard Base
Governors Island
New York, N. Y. 10004

13. Commander (oms) 1
Western Area, U.S. Coast Guard
630 Sansome Street
San Francisco, California 94126

14. Lt. William A. Caster, USCG 3
USCG ROCKAWAY (WAGO-377)
U. S. Coast Guard Base
Governors Island
New York, N. Y. 10004

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) Naval Postgraduate School Monterey, California 93940	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

Near-Bottom Currents in Monterey Submarine Canyon and on the Adjacent Shelf

4. DESCRIPTIVE NOTES (Type of report and, inclusive dates)

Master's Thesis; October 1969

5. AUTHOR(S) (First name, middle initial, last name)

William Albert Caster

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
October 1969	202	22

8a. CONTRACT OR GRANT NO. b. PROJECT NO. c. d.	9a. ORIGINATOR'S REPORT NUMBER(S) 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Naval Postgraduate School Monterey, California 93940

13. ABSTRACT

Near-bottom currents in Monterey Submarine Canyon and the adjacent shelf were collected using Savonius current meters. Simultaneous measurements were made with one current meter on the shelf at a depth of 91 meters and one meter located in the Canyon at 366 meters. Another record was taken in the Canyon at the 366-meter location. Current speed, current direction and water temperature were recorded continuously for approximately seven days in each record. First-order statistics were calculated and plotted for these time-series data. Scatter diagrams, progressive vector diagrams and power spectra were also computed and analyzed for the records collected during this study and for records of sufficient length from previous investigations.

Net current set was in a cross-canyon direction for many of the records; however, the currents in the Canyon oscillated as reported in previous investigations. The oscillations were not as evident on the shelf record. Mean and maximum current speeds recorded in the Canyon were 10 and 51 cm/sec, respectively. On the shelf these values were 7 and 25 cm/sec. Observed values of net current set and volume transport are related to Monterey Bay seasonal water conditions.

DD FORM 1 NOV 65 1473 (PAGE 1)

S/N 0101-807-6811

Security Classification

A-31408

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Near-bottom Currents						
Monterey Bay						
Monterey Submarine Canyon						
Submarine Canyon Currents						
Ocean Currents						

DD FORM 1 NOV 65 1473 (BACK)

S/N 0101-807-6821

A-31409